UNITED STATES DEPARTMENT OF COMMERCE

FINAL

ENVIRONMENTAL IMPACT STATEMENT

MARITIME ADMINISTRATION

TITLE XI

VESSELS ENGAGED IN OFFSHORE OIL AND GAS DRILLING OPERATIONS

MARITIME ADMINISTRATION · DEPARTMENT OF COMMERCE · 1950

MA-EIS-7302-76015F

Maritime Administration Title XI Vessels Engaged in Offshore Oil and Gas Drilling Operations

( ) (X) Final Environmental Statement

Responsible Office: U.S. Department of Commerce
Maritime Administration
Washington, D.C.

1. Type of Action: (X) Administrative ( ) Legislative

2. Project Description:

To provide assistance in the construction of Offshore Oil and Gas Drilling and Support Vessels in the guarantee of financial obligations (notes, bonds, etc.) including interest, that are obtained in the private market by U.S. citizens for the construction of such vessels in United States shipyards under Title XI financing.

3. Environmental Impacts:

Environmental impact of the project poses some degree of pollution risk to the marine environment and adjacent shoreline. The risk potential is related to adverse effects on the environment and other resource use which may result from accidental or chronic oil spillage and the release of oily waste water resulting from operational procedures.

4. Alternatives Considered:

Alternatives to Title XI financing for the construction of Offshore Oil and Gas Drilling and Support Vessels have been considered in the statement and include withdrawing government support in providing guaranteed obligations and reference to the U.S. Department of the Interior "Energy Alternatives and their Related Environmental Impacts."

5. <u>Comments Requested:</u>

Environmental Protection Agency
Department of State
Department of Defense
Department of Transportation
U.S. Coast Guard
Department of Treasury
Atomic Energy Commission
Federal Power Commission
Department of Interior
  Bureau of Sport Fisheries and Wildlife
  Bureau of Outdoor Recreation
  Bureau of Mines
  Geological Survey
  National Park Service
  Office of Oil and Gas
State of Alabama
State of Alaska
State of California
State of Connecticut
State of Delaware
State of Florida
State of Georgia
State of Louisiana
State of Maine
State of Maryland
State of Massachusetts
State of Mississippi
State of North Carolina
State of New Jersey
State of New York
State of Oregon
State of Rhode Island
State of South Carolina
State of Texas
State of Virginia
State of Washington

6. Draft Statement made available to the Council on Environmental Quality and the public on May 2, 1975.

7. Final Statement made available to the Council on Environmental Quality and the public

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CHAPTER I
DESCRIPTION OF PROJECT

A. THE OFFSHORE OIL AND GAS DRILLING AND SUPPORT VESSEL PROGRAM

The Maritime Administration Offshore Oil and Gas Drilling and Support Vessel Program (hereinafter referred to as the "Program") involves the financing of offshore oil and gas drilling units and support vessels under Title XI of the Merchant Marine Act. The Federal ship financing program, established pursuant to Title XI of the Merchant Marine Act, 1936, as amended, provides for a full faith and credit guarantee by the United States Government of debt obligations issued by United States citizen shipowners for the purpose of financing or refinancing United States flag vessels constructed or reconstructed in United States shipyards. To date, 26 loan guarantees have been approved for the offshore program totalling \$432, 469, 519 in commitments. Actual cost of these 26 units was \$572, 818, 946. Of the 26 units 18 are semisubmersibles (a commitment of \$348, 512, 519), four drillships (a commitment of \$25, 318, 000) and four are jack-ups (a commitment of \$58, 639, 000). Thirteen of the 26 are still under construction. Of the thirteen which have been delivered, twelve are actively employed in drilling and one is enroute to a new drilling site with a contract running to March 1976. As of March 1975, only three of the 13 units now under construction do not have firm contracts.

As of July 1975, there were six active and pending Title XI applications for nine new rigs involving a commitment of \$281, 100, 000. Four of the nine are for jack-ups; three are drillships and two are semisubmersibles.

The Maritime Administration Title XI financing program was one of the major factors allowing U.S. offshore drilling companies to build offshore drilling vessels before foreign concerns entered this important market. As a result, many of the U.S. offshore drilling companies are in an advantageous competitive position in the world market.

The Maritime Administration Title XI financing allowed several smaller U.S. companies to participate in the expansion of the offshore drilling industry which might not have been possible otherwise. This should provide a healthier competition in the offshore drilling industry and hopefully provide lower costs of petroleum products for the consumer.

It is expected that with the worldwide energy shortage the U.S. will begin searching for more reliable sources for obtaining the necessary energy resources to meet our needs. Of course, this must include increases in domestic energy supplies, which are expected to fall short of U.S. energy demands within the next ten to twenty years. As part of this plan, increased exploration on the Outer Continental Shelf can be expected to take place. Table 1-1 shows the one hundred largest crude oil fields in the U.S. including the OCS.

The Offshore Program is designed in part to serve these purposes. Modern drilling and support vessels will facilitate the necessary exploratory work in order to uncover petroleum sources located under the Outer Continental Shelf and other submerged public lands. It can be expected that most of the petroleum which is produced through the efforts of these vessels will be transported to the U.S. for refinement and used domestically, thus contributing to national economic and defense goals. Hence, the 1970 Program and the Title XI program require the construction of these specialized drilling and support vessels to ensure adequate participation by the American merchant marine in this area of marine operations and to maintain the Maritime Administration's goal of a balanced fleet meeting our country's needs.

In evaluating an application for Title XI assistance in the construction of offshore drilling and support vessels the plans and specifications detailing the design and construction requirements of the proposed vessel are carefully reviewed by the Maritime Administration to assure that it will meet or exceed the requirements of the Regulatory Bodies that will assure maximum protection of the marine environment. Table 1-2 lists the number of applications approved under the program together with the number and type of drilling or support vessels.

B. TITLE XI FINANCING

1. PURPOSE

The primary purpose of the Title XI program is to promote the growth and modernization of the United States Merchant Marine by issuing guarantees of obligations to enable the financing and refinancing of vessels constructed in the United States and owned and operated by citizens of the United States. The program enables owners of eligible vessels to obtain long-term financing on favorable terms and conditions and at interest rates that are

TABLE I-1

THE ONE HUNDRED LARGEST FIELDS IN THE U.S. WITH REMAINING ESTIMATED PROVED RESERVES OF CRUDE OIL AND "NINETY DAY" DAILY PRODUCTIVE CAPACITY ESTIMATED AS OF DECEMBER 31, 1974

(Barrels of 42 Gallons)

Field			Remaining Proved Crude Oil Reserves 12/31/74	Daily Crude Oil Productive Capacity 90 - Days From 12/31/74
Prudhoe Bay	North Slope Borough	Alaska	9,598,511,000	1,500
Yates	Pecos County	Texas - Dist. 8	1,398,000,000	250,000
East Texas	Cherokee, Gregg, Rusk, Smith, & Upton Counties	Texas - Dist. 6	1,287,165,000	400,000
Elk Hills	Kern County	California (San Joaquin Region)	705,754,000	160,000
Wilmington	Los Angeles County	California (Los Angeles Region)	705,400,000	180,000
Wasson	Gaines County	Texas - Dist. 8A	636,000,000	247,500
Kelly Snyder	Scurry County	Texas - Dist. 8A	477,000,000	210,000
Slaughter	Cochran County	Texas - Dist. 8A	349,000,000	130,000
Tom O' Connor	Refugio County	Texas - Dist. 2	314,669,000	122,000
Hawkins	Wood County	Texas - Dist. 6	304,762,000	133,050
Midway-Sunset	Kern & San Luis Obispo Counties	California (San Joaquin Region)	303,794,000	98,000
Sho-Vel-Tum	Carter & Stephens Counties	Oklahoma	297,651,000	95,000
Jay	Escambia & Santa Rosa Counties	Florida and Alabama	267,936,000	93,606
Hastings, West	Brazoria County	Texas - Dist. 3	253,212,000	75,000
Kern River	Kern County	California (San Joaquin Region)	250,528,000	73,000
McArthur River	Kenai Peninsula Borough	Alaska	249,660,000	113,000
Webster	Harris County	Texas - Dist. 3	225,960,000	68,924
Caillou Island	Terrebonne Parish	Louisiana - South	205,086,000	43,175
Rangely	Rio Blanco County	Colorado	198,710,000	55,000
Conroe	Montgomery Co.	Texas - Dist. 3	196,774,000	60,827
Cowden, North	Ector County	Texas - Dist. 8	165,000,000	42,100
Seminole	Gaines County	Texas - Dist. 8A	162,000,000	60,000
Delta, West, Block 58	Plaquemines Parish - Offshore	Louisiana - South	161,337,000	28,000
Fullerton	Andrews County	Texas - Dist. 8	153,000,000	17,800
Bay Marchand Block 2	Lafourche Parish - Offshore	Louisiana - South	126,053,000	84,000
Panhandle	Hutchinson County	Texas - Dist. 10	124,860,000	31,000
Levelland	Cochran County	Texas - Dist. 8A	122,000,000	35,000

Source: American Petroleum Institute

The One Hundred Largest Fields in the U.S.

Field			Remaining Proved Crude Oil Reserves 12/31/74	Daily Crude Oil Productive Capacity 90 - Days From 12/31/74
Huntington Beach	Orange County	California (Los Angeles Region)	121,530,000	51,000
Grand Isle, Block 43	Plaquemines Parish - Offshore	Louisiana - South	119,776,000	65,000
Eugene Island Block 330	Iberia Parish Offshore	Louisiana - South	116,348,000	73,300
Delta, West Block 30	Plaquemines Parish - Offshore	Louisiana - South	110,125,000	46,700
Cote Blanche Bay, West	St. Mary Parish	Louisiana - South	103,138,000	21,500
Delhi	Franklin, Madison, & Richmond Parishes	Louisiana - North	102,359,000	17,968
San Ardo	Monterey County	California (Coastal Region)	101,079,000	37,000
Middle Ground Shoal	Kenai Peninsula Borough	Alaska	97,836,000	24,000
South Pass Block 27	Plaquemines Parish - Offshore	Louisiana - South	97,161,000	31,000
West Ranch	Jackson County	Texas - Dist. 2	96,266,000	39,838
Garden Island Bay	Plaquemines Parish	Louisiana - South	94,968,000	21,500
Hondo	Santa Barbara County	California (Coastal Region)	94,000,000	0*
Thompson	Fort Bend County	Texas - Dist. 3	93,717,000	37,836
Ventura	Ventura County	California (Coastal Region)	91,835,000	31,000
Goldsmith	Ector County	Texas - Dist. 8	91,000,000	40,500
Empire	Eddy County	New Mexico	90,697,000	48,019
Van	Van Zandt County	Texas - Dist. 5	89,997,000	55,901
Fairway	Anderson & Henderson Counties	Texas - Dist. 5 & 6	89,922,000	31,020
South Pass Block 24	Plaquemines Parish - Offshore	Louisiana - South	85,621,000	40,000
Vacuum	Lea County	New Mexico	83,459,000	38,453
Salt Creek Light Oil Unit	Natrona County	Wyoming	82,487,000	32,400
Belridge South	Kern County	California (San Joaquin Region)	80,718,000	23,000
Howard Glasscock	Howard County	Texas - Dist. 8	80,000,000	18,100
Midland Farms	Andrews County	Texas - Dist. 8	79,000,000	14,500
Ship Shoal Block 207	Terrebonne Parish - Offshore	Louisiana - South	78,266,000	14,000
South Pass Block 61	Plaquemines Parish - Offshore	Louisiana - South	77,157,000	20,000

*Undeveloped

The One Hundred Largest Fields in the U.S.

Field			Remaining Proved Crude Oil Reserves 12/31/74	Daily Crude Oil Productive Capacity 90 - Days From 12/31/74
Cogdell	Kent County	Texas - Dist. 8A	76,000,000	33,100
Main Pass Block 41	Plaquemines Parish - Offshore	Louisiana - South	74,847,000	22,000
Dos Cuadras	Santa Barbara County	California (Coastal Region)	72,977,000	40,000
Diamond M	Scurry County	Texas - Dist. 8A	72,000,000	18,400
Coalinga	Fresno County	California (San Joaquin Region)	71,934,000	17,000
Lafitte	Jefferson Parish	Louisiana - South	71,828,000	15,050
Elk Basin	Park County	Wyoming	68,950,000	20,800
Swanson River	Kenai Peninsula Borough	Alaska	68,878,000	26,000
Main Pass Block 306	Plaquemines Parish - Offshore	Louisiana - South	67,289,000	11,170
Sooner Trend	Kingfisher County	Oklahoma	64,145,000	27,000
Andector	Ector County	Texas - Dist. 8	63,000,000	17,200
Eunice	Lea County	New Mexico	61,966,000	11,000
Golden Trend	Garvin County	Oklahoma	61,780,000	19,000
Lake Pasture	Refugio County	Texas - Dist. 2	61,766,000	15,000
Neches	Anderson & Cherokee Counties	Texas - Dist. 6	61,702,000	16,728
Oregon Basin	Park County	Wyoming	61,268,000	33,100
Lake Washington	Plaquemines Parish	Louisiana - South	61,170,000	18,000
Altamont	Duchesne County	Utah	58,814,000	32,000
Tule Elk	Kern County	California (San Joaquin Region)	58,232,000	30,000
Healdton	Carter County	Oklahoma	58,119,000	20,000
Foster	Ector County	Texas - Dist. 8	58,000,000	17,600
Anahuac	Chambers County	Texas - Dist. 3	56,390,000	24,339
Bay St. Elaine	Terrebonne Parish	Louisiana - South	55,172,000	11,140
Oyster Bayou	Chambers County	Texas - Dist. 3	54,848,000	16,046
Bluebell	Duchesne & Uintah Counties	Utah	53,882,000	32,000
Granite Point	Kenai Peninsula Borough	Alaska	53,864,000	12,200
Timbalier Bay Block 21	Lafourche Parish - Offshore	Louisiana - South	53,641,000	32,000
Talco	Franklin & Titus Counties	Texas - Dist. 6	53,117,000	10,360
Salt Creek	Kent County	Texas - Dist. 8A	53,000,000	36,500
Venice	Plaquemines Parish	Louisiana - South	51,952,000	12,165
Bell Creek	Powder River Co.	Montana	51,094,000	25,500
Cote Blanche Island	St. Mary Parish	Louisiana - South	51,002,000	14,300

Field			Remaining Proved Crude Oil Reserves 12/31/74	Daily Crude Oil Productive Capacity 90 - Days From 12/31/74
Delta, West Block 73	Plaquemines Parish - Offshore	Louisiana - South	50,901,000	18,750
Grand Isle Block 16	Jefferson Parish Offshore	Louisiana - South	50,530,000	31,600
Hobbs	Lea County	New Mexico	50,321,000	12,600
McKittrick	Kern County	California (San Joaquin Region)	49,427,000	16,000
McElroy	Crane County	Texas - Dist. 8	49,000,000	30,500
Ship Shoal Block 208	Terrebonne Parish - Offshore	Louisiana - South	48,574,000	25,700
Bay de Chene	Jefferson & Lafourche Parishes	Louisiana - South	47,067,000	14,392
Sprayberry Trend	Reagan County	Texas - Dist. 7C	45,635,000	14,438
Postle	Texas County	Oklahoma	44,021,000	16,000
Prentice	Yoakum County	Texas - Dist. 8A	44,000,000	16,200
Main Pass Block 69	Plaquemines Parish - Offshore	Louisiana - South	43,871,000	19,000
Lost Soldier	Sweetwater County	Wyoming	43,299,000	9,100
Beaver Lodge	Williams County	North Dakota	43,136,000	8,500
Teapot Dome	Natrona County	Wyoming	42,515,000	2,500
Lake Barre	Terrebonne Parish	Louisiana - South	42,254,000	10,000

* * * * * * * * * * *

SUMMARY

Total United States	34,249,956,000	8,877,000
Total One Hundred Largest Fields	24,345,462,000	4,712,995
Per Cent of Total United States	71.1 %	53.1 %

TITLE XI APPLICATIONS RECEIVED AND COMMITMENTS ISSUED BY FISCAL YEAR FOR OFFSHORE DRILLING AND SERVICE VESSELS

FISCAL YEARS	1971		1972		1973		1974		OUTSTANDING APPLICATIONS AS OF 6/30/74
	A	C	A	C	A	C	A	C	
FLOATING DRILL SHIPS & BARGES	2		3	1	9	5	12	3	11
JACK-UP DRILLINGS	1		1		1		4		5
SEMI-SUBMERSIBLE DRILLING RIGS	2		8	7	3	2	8	1	9
SUBMERSIBLE DRILLING RIGS									
SUBTOTAL	5	0	12	8	13	7	24	4	25
OFFSHORE SERVICE VESSELS									
TUGS			9	3	37	21	22	24	30
SUPPLY VESSELS			2		13		3	6	10
CREW BOATS					2	2	1	1	0
SUBTOTAL	0	0	11	3	52	23	26	31	40
TOTAL - ALL OFFSHORE VESSELS	5	0	23	11	65	30	50	35*	65

A - APPLICATIONS RECEIVED C - COMMITMENTS ISSUED

TABLE I-2

comparable to those available to large and financially strong corporations. Such favorable financing terms are usually not available to the average shipowner.

The Title XI program is administered by the Assistant Secretary for Maritime Affairs (Secretary) on behalf of the Secretary of Commerce. The guarantee of the United States Government under this program provides for the prompt payment in full of the interest on the unpaid principal of any guaranteed obligation in the event of default by the shipowner in the payment of any principal and interest on the obligations when due or for other specific defaults. The Federal Ship Financing Fund established pursuant to Title XI is used by the Secretary as a revolving fund for the purpose of underwriting the Government's guarantee and to pay the expenses of the program. In addition, the Secretary is authorized to borrow from the United States Treasury in the event the Fund is insufficient for the purpose of making prompt payments under its guarantee. In 1973 Congress established a Fund ceiling of $5 billion and the Congress is now considering raising this ceiling to $8 billion.

As of July 31, 1975 a total of $4.7 billion had been committed to guarantee loans under the Title XI program.

2. ELIGIBILITY REQUIREMENTS

Vessels eligible for Title XI assistance generally include vessels designed principally for research or commercial use and over five net tons. However, any towboat, barge, scow, lighter, car float, canal boat, or tank vessel, to be eligible, must be more than 25 gross tons and floating drydocks must have a capacity of 35,000 or more lifting tons and a beam of 125 feet or more between the wing walls.

The design of the vessel must be adequate from an engineering viewpoint for its intended use, and the delivered vessel must be classed by the American Bureau of Shipping as Class A-1, or meet other standards acceptable to the Secretary. The shipowner must be a United States citizen and have sufficient operating experience and the ability to operate the vessel on an economically sound basis. The shipowner must meet certain financial requirements with respect to working capital and net worth, both of which are based on such factors as the amount of the guaranteed obligations, the shipowner's financial strength, intended employment of the vessel, etc. These factors also affect the terms of the guarantee with respect to continuing Title XI financial covenants, guarantee fees, reserve fund, etc. No guarantee under this program can be legally entered into unless the project is determined by the Secretary to be economically sound.

3. PROCEDURE

Application forms for Title XI are obtained from the Maritime Administration. Attached to the application is a copy of General Order 29, Revised, which constitutes the rules and regulations governing the operation of Title XI. Twelve completed sets of the application, including schedules and exhibits as required, are sent to the Maritime Administration accompanied by a filing fee of $100.00 which is not refundable.

Approval of the application is contingent upon the determination by the Secretary as to whether the vessel(s) and the project meet all the applicable requirements of the existing statutes and regulations. If the application is approved, a conditional letter commitment to guarantee the obligation is issued, stating the requirements necessary for final approval (usually within 90 days). The applicant is notified in writing when the application is not approved. Final approval of the application is accomplished after the formal documentation of the transaction and all the conditions in the letter of commitment are satisfied. At such time the Secretary enters into a formal Commitment to Guarantee and guaranteed obligations (notes and bonds) is issued and sold and a secured interest or a mortgage on the vessel(s) recorded.

4. AMOUNT GUARANTEED

The amount of the obligation guaranteed by the Government is based on the "actual cost" of the vessel as determined by the Secretary. The actual cost of a vessel includes those items which would normally be capitalized as vessel costs under usual accounting practices, such as the cost of construction, reconstruction, or reconditioning (including designing, inspecting, outfitting and equipping) of the vessel, together with commitment fees and interest on the related loan during the period of construction. All items of actual cost must be determined to be fair and reasonable by the Secretary. Some costs are excluded from actual cost (and are sometimes considered capitalizable costs) such as legal and accounting fees, printing costs, guarantee fees, vessel insurance and underwriting fees and any interest on borrowings for the ship-owner's equity in the vessel(s).

The Secretary is authorized to guarantee an obligation which does not exceed 75 percent of the actual cost of most eligible vessels. However, obligations may be guaranteed in an amount not exceeding 87 1/2 percent of the actual cost of (1) passenger vessels designed to be of not less than 1,000 gross tons and capable of a sustained speed of not less than 8 knots, to be used solely on inland rivers and waterways; (2) oceangoing tugs of more than 2,500 horse-power; (3) barges; (4) vessels of 25,000 horsepower designed to be capable

of a sustained speed of not less than 40 knots; and (5) other vessels of not less than 3,500 gross tons and capable of a sustained speed of 14 knots. Vessels built with construction-differential subsidy or vessels other than barges and passenger vessels in (1) above engaged solely in the transportation of property on inland rivers and canals exclusively are eligible only for a guarantee not exceeding 75 percent of their actual cost.

If a Title XI guarantee of an obligation for a vessel is documented after delivery or for refinancing, the actual cost must be depreciated from the date of delivery to the documentation date of guarantee.

5. SOURCE OF FUNDS

Since the program is a guarantee program and not a direct loan program, funds secured by the guaranteed debt obligations and used for the financing of the vessel(s) are obtained in the private sector. The main sources for such funds include banks, pension trusts, life insurance companies and bonds sold to the general public.

6. AMORTIZATION AND INTEREST RATE

The maximum guarantee period is 25 years from the date of delivery, however, if the vessel has been reconstructed or reconditioned, the life may be extended by the Secretary to include the remaining useful years of the vessel as determined by the Secretary. Amortization in equal payments of principal is usually required, however, other amortization methods such as level debt (equal payments of principal and interest) may also be approved if sufficient security is offered such as long term charters, reduction of the amount of guarantee and/or length of guarantee period.

The interest rate of the obligation guaranteed, for both new and refinanced vessels, must be within the range of interest rates prevailing in the private market for similar loans and risks and must be determined to be fair and reasonable by the Secretary.

7. INVESTIGATION FEE

An investigation fee, not exceeding one-half of 1 percent of the original principal amount of the obligation to be guaranteed, is charged for the investigation of applications, including related appraisals and inspections. Generally, a fee of only slightly in excess of one-eighth of the 1 percent is charged. If the application is not approved, one-half of the fee is refundable.

8. ANNUAL GUARANTEE FEES

The fee for the guarantee of an obligation for a delivered vessel will be not less than one-half of 1 percent or more than 1 percent per annum, of the average principal amount of the outstanding obligation, or not less than one-quarter of 1 percent or more than one-half of 1 percent per annum, of the principal amount of an obligation relating to a vessel under construction, reconstruction or reconditioning. Amounts on deposit for the vessel is in escrow fund held by the U. S. Treasury pursuant to Title XI are excluded in the computation of this charge. The fee is required by law to be paid annually in advance.

Unless otherwise determined by the Secretary, the annual premium rates are based on a ratio of net worth to long-term debt of the shipowner, and are subject to annual adjustment except during the construction period.

9. "BUY AMERICAN" POLICY

The Maritime Administration's long-standing policy has been that vessels built with the aid of Title XI are subject to the "Buy American" provision of Section 505 of the Act which states in part:

> "In all such construction the shipbuilder, subcontractors, materialmen or suppliers shall use, so far as practicable, only articles, materials and supplies of the growth, production, or manufacture of the United States as defined in paragraph K of Section 401 of the Tariff Act of 1930."

Pursuant to Title XI the shipowner may be permitted to use components of foreign manufacture, providing: (1) the performance of the vessel will not be adversely affected and (2) the incorporation of such foreign components into the vessel will not impair its entitlement to operate in the coastwise trade of the United States or to carry preference cargoes. However, if foreign components are used, the cost thereof will be excluded from actual cost if the Secretary determines that suitable American domestically produced components are available. This reduction in actual cost will increase the owner's share of the total cost of the vessel and reduce the amount of the guaranteed obligation.

10. REFINANCING

Amounts outstanding on existing Title XI obligations, or amounts outstanding on obligations not previously insured or guaranteed (provided they had been issued for the purposes contained in Title XI) may be refinanced under the Title XI program up to the amount of the depreciated actual cost of the vessel(s)

but not exceeding the amount of the existing obligations being refinanced. Such financing under Title XI must meet all the applicable requirements of the existing statutes and regulations, and the original obligation must have been issued within one year after vessel delivery. Vessels purchased as "used" vessels are not eligible under this provision. However, under certain conditions the proceeds of guaranteed obligations issued with respect to any eligible vessel may be used for the construction of a new vessel or for the purchase of certain marine equipment.

C. OPERATING, TECHNICAL CHARACTERISTICS AND TYPES OF OFFSHORE OIL AND GAS DRILLING VESSELS

One of the key developments in the spectacular growth of the offshore oil industry during the past 25 years has been the development of offshore mobile drilling units.

The many unusual designs developed to solve various problems is one of the important engineering achievements of this century. This section will review how these units evolved -- and make some predictions about future developments.

An offshore mobile unit, as defined in this section, is any portable unit containing a drilling rig capable of working in open water 20 ft. or deeper. Included are mobile units supported by drilling tenders and the new special mobile workover units.

Drilling units, as defined below, can be categorized into one of the following four groups:

1. Submersible - Drilling platform resting on the sea bed during drilling, usually equipped with a lower column section having enough buoyant capacity to keep the rig afloat while being moved.

2. Floating Drillship and Barge - Ship-shaped or barge-shaped hulls equipped for drilling while floating on the water surface.

3. Jack-up Drill Unit - Self-elevating platform equipped with legs which can be lowered until they reach the sea bed and support the main section of the drilling platform. During drilling operations, this platform is kept in a jack-up position above the water surface.

4. Semi-submersible - Floating drilling platform which by means of water ballast can be submerged to a pre-determined draft so that a substantial portion of the columns or other stabilizing devices are lowered during drilling operations.

There have been three periods of rapid growth -- 1953-58 when many submersibles and jack-ups were designed for the Gulf of Mexico, 1962 to 1967 and 1971 to date when floating and jack-up rigs were built in great numbers for world-wide use.

In the past 10 years there has been a substantial increase in number of rigs for the 100-300 ft. range (primarily jack-ups) and a substantial jump in number of floating rigs, including semi-submersibles which operate in deeper depths.

The oil industry's mobile marine drilling fleet is growing at an extremely rapid pace. During the 12 month period ending September 1974, the number of mobile units had increased from 319 units to 408 units. This new figure includes the 268 units in operation and 140 which are under construction or planned.

Of the 408 units in operation, 173 (43%) are jack-ups, 128 (31%) are semi-submersibles, 20 (5%) are submersibles, 87 (21%) are drillships and drill barges.

Of the 140 new units under construction and planned, 26 are drill ships and drill barges, 34 are jack-ups and 80 are semi-submersibles.

The continuation of the construction boom is necessary to meet the growing demand for more energy throughout the world. As can be noted, the new and planned vessels will be capable of working in deep water while encountering the most severe sea and weather conditions.

Offshore drilling rigs have been developed over a period of time to drill from coastal marshlands out to 3,000 feet of water in the open sea. There are five classifications of rigs, i.e. Drill Barge, Submersible, Jack-up, Semi-Submersible and finally the Drill Ship for operation in deep water. Drilling operations so far, have not exceeded 2,300 feet of water depth. Water depth, maximum sea and wind conditions, bottom conditions, and maximum loads to be carried are among the primary factors influencing the design of a unit.

A careful evaluation of the anticipated service over the lifetime of the rig is needed. This involves estimated future markets and uses for the units as well as the environments in which they are expected to operate.

Some of the basic elements which determine the characteristics of a rig design are as follows:

Water depth
Wind, wave, tide and current
Mobility
Loads to be carried
Number of crewmen
Bottom soil conditions
Surface or subsea well completions
Desired maximum motions
Stability requirements, operational and regulatory
Structural design criteria, operational and regulatory

In most places of the world, severe oceanographic events, such as hurricanes, typhoons and broad low pressure systems determine design conditions. In these more severe environments, past experience and research is proving to be quite useful.

Weather data taken over a period of time, preferably a number of years, is reduced and coupled with mathematical extrapolations to determine rare occurrences. This data includes:

Sea state probability
Wave period occurrence probability
Current occurrence probability
Current direction probability
Wind velocity probability
Wind direction probability
25, 50 and 100 year conditions

Some oil producing areas have little or no reliable weather forecasting. As a result, designers and business managers normally plan structures and vessels to sustain the worst known environmental conditions in any given area. This is not to say that there is absolutely no risk involved. To virtually eliminate risk one would have to assume that in a given area the worst sea, current and wind may occur simultaneously and from the same direction. The probability of this occurring in most areas is

extremely low. A reasonable approach is to establish an order of annual probability for each element and determine their product. The product of the annual probability of simultaneous occurrence should not be higher than 0.02. If no reliable direction information is available, sea current and wind are assumed to act from the same direction.

The current selection of the most appropriate unit for offshore drilling boils down to water depth considerations.

In very shallow water, say 20 ft. deep, a mobile platform could be a simple barge hull with structural support columns to support a raised platform. This hull would be submerged by lowering one end to the bottom first. In going deeper, to about 150 ft. there is a choice between fixed height platform of a jack-up rig. In the case of a fixed height platform, the barge would ordinarily have stability columns to permit raising and lowering on an even keel. Such a platform could work bottom-supported to the limit of its proportions, or it could work as a semi-submersible in any water depth in which it could be anchored or dynamically positioned. The largest submersible rig built to date was designed for drilling on the bottom in 175 ft. water depth, but this is considered to be about the limit and somewhat beyond the range of economical construction cost under the present state of technology.

Jack-up drill units are designed for water depths of about 300 ft.; however, a jack-up drill unit could be designed for up to possibly 400 or 500 ft. of water depth depending upon prevailing sea conditions of a particular drilling site. The structural problems are considerable in such extreme water depth and probably 300 ft. is a more practical limit. A semi-submersible or a floating rig is more economical in greater depths.

1. SUBMERSIBLES

The first offshore mobile unit, a submersible, was the Barnsdall-Hayward "Breton Rig 20". This rig, which is now Kerr-McGee's "Rig 40," is pictured in Figure I-1. This unit evolved from the inland drill barges which were being used to drill in the marshes and protected bays in 10 ft. of water or less. The first of the inland barge rigs was the Giliasso-type barge which was built in 1933. It has a U-shaped hull with a long, narrow slot that allowed the derrick to be located approximately amidships. Another type of unit consisted of two barges connected by a truss, with the derrick positioned between the barges. As the water depth requirements increased, the drilling decks were raised by adding vertical structural members; hence these units are often called posted barges. The basic problem being that these units are unstable when the main barge hull is totally submerged.

The answer to this stability problem was the "Breton Rig 20" design. This unit used pontoons which could stay on the surface while the barge was being set on the bottom. After the barge was in place, the pontoons were lowered to the bottom to minimize wave forces. This concept proved successful, and this unit is still operational. Two other units have been built with vertically movable pontoons - Kerr - McGee's "Rig 44" and "Rig 45."

Other solutions to the stability problem were developed in the mid-1950's. One early offshore mobile unit, ODECO's "Mr. Charlie" Figure I-2 used hinged pontoons to provide stability while sinking. Only one other unit the "American Tidelands 101," was built with hinged pontoons. Both of these units were converted to fixed pontoons shortly after they were built. It is interesting to note that "Mr. Charlie" also used large-diameter columns to provide floating stability. This was the first step in the development of the bottle-type unit which will be discussed later. At the same time "Mr. Charlie" was being built, Friede and Goldman developed a design which used recessed pads or feet that could be lowered to the bottom to establish a firm footing before the unit was sunk into position. The California Company's "S-44" and approximately eight other units were built using this principle. All of these units have been converted to bottles to get away from the problem of moving parts.

ODECO's "John Hayward" Figure I-3 was designed with fixed hull extensions fore and aft. This dumbbell hull (so-named because its plan profile resembles a dumbbell) serves two purposes while the barge is being sunk. The extensions on one end of the barge give it mechanical stability as they contact the soil, while the other pair of extensions are providing water-plane area to give floating stability. Approximately seven of these units have been built. One reason for their success is that they have no moving stability members. As indicated above, the trend with the submersible has been away from moving parts which can be damaged or cause operating problems during rig moves.

One problem which beset all of the early submersible units was that of being moved off location by moderately severe storms. After several of these units were built, it was discovered that, although the barge hull is resting on the bottom, it is still subjected to some substantial wave forces. Also, the soil is scoured from around the hull by waves and currents. A partial solution to these two problems, which has been used by most of the submersible units operating in soft-bottom areas, was to add mud skirts or fiddle boards to the periphery of the hull. These skirts, which are up to five feet deep, have overcome most of the difficulties. In

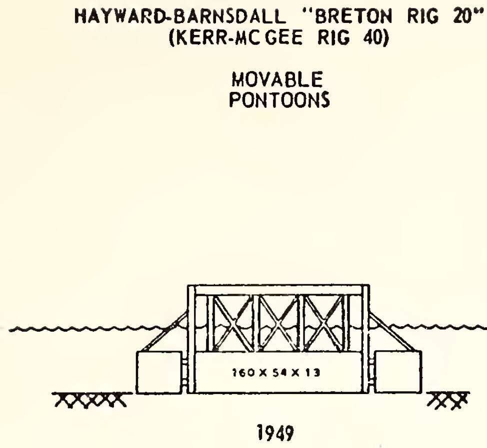


Figure I-1

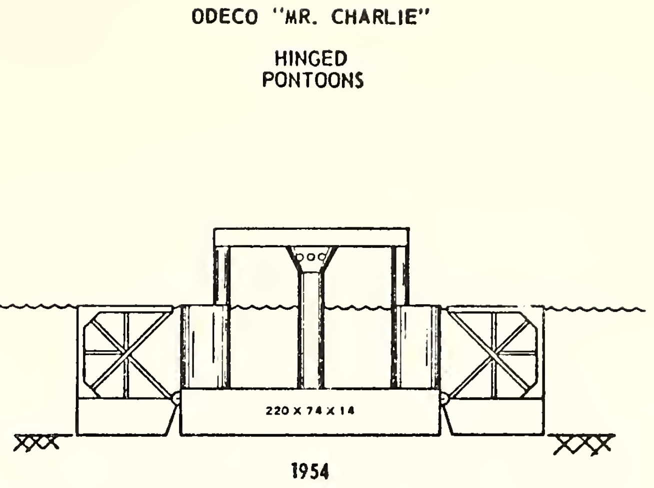


Figure I-2

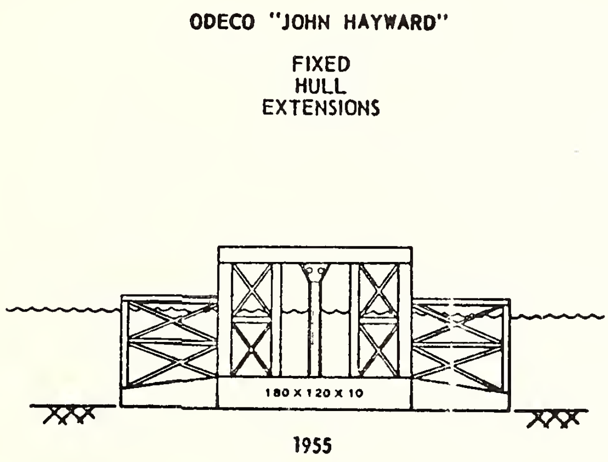


Figure I-3

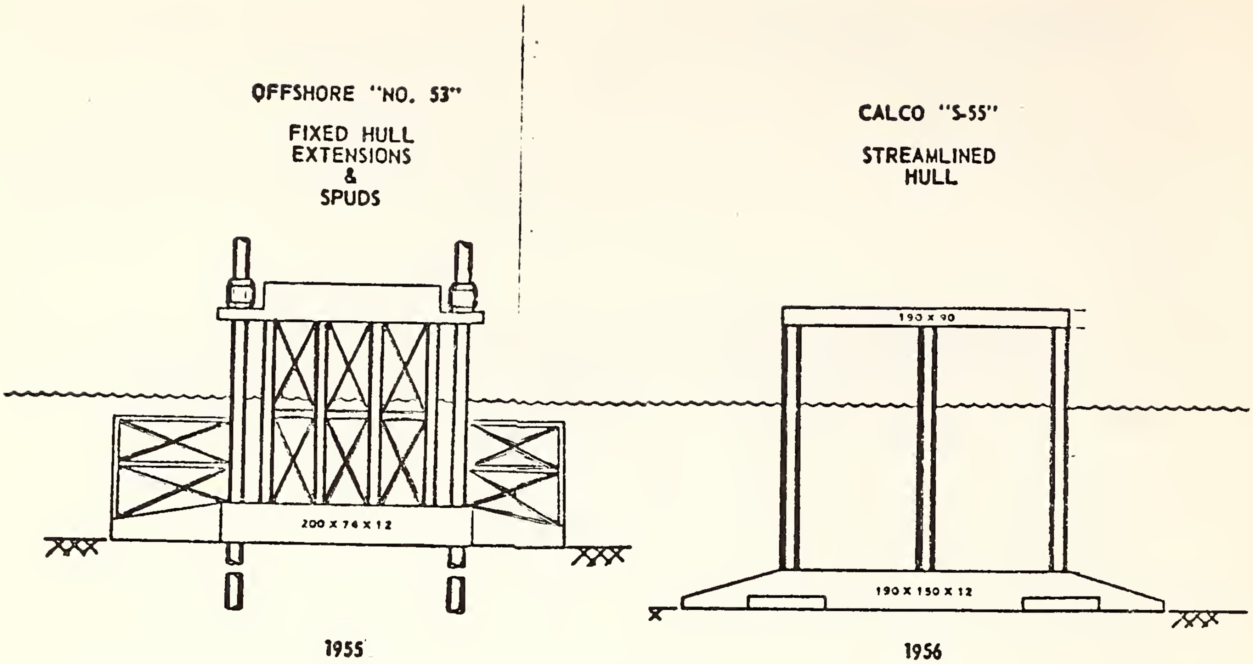


Figure I- 4

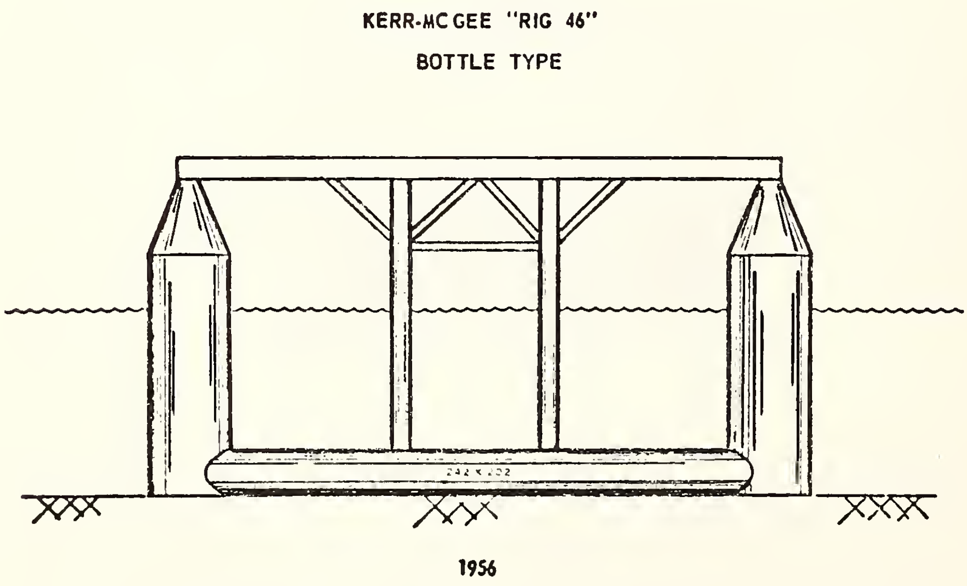
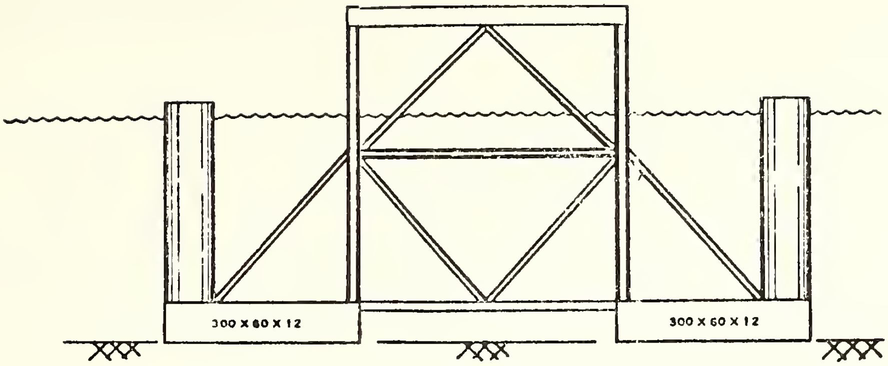


Figure I- 5

ODECO "MARGARET"

CATAMARAN
HULL WITH
BOTTLES

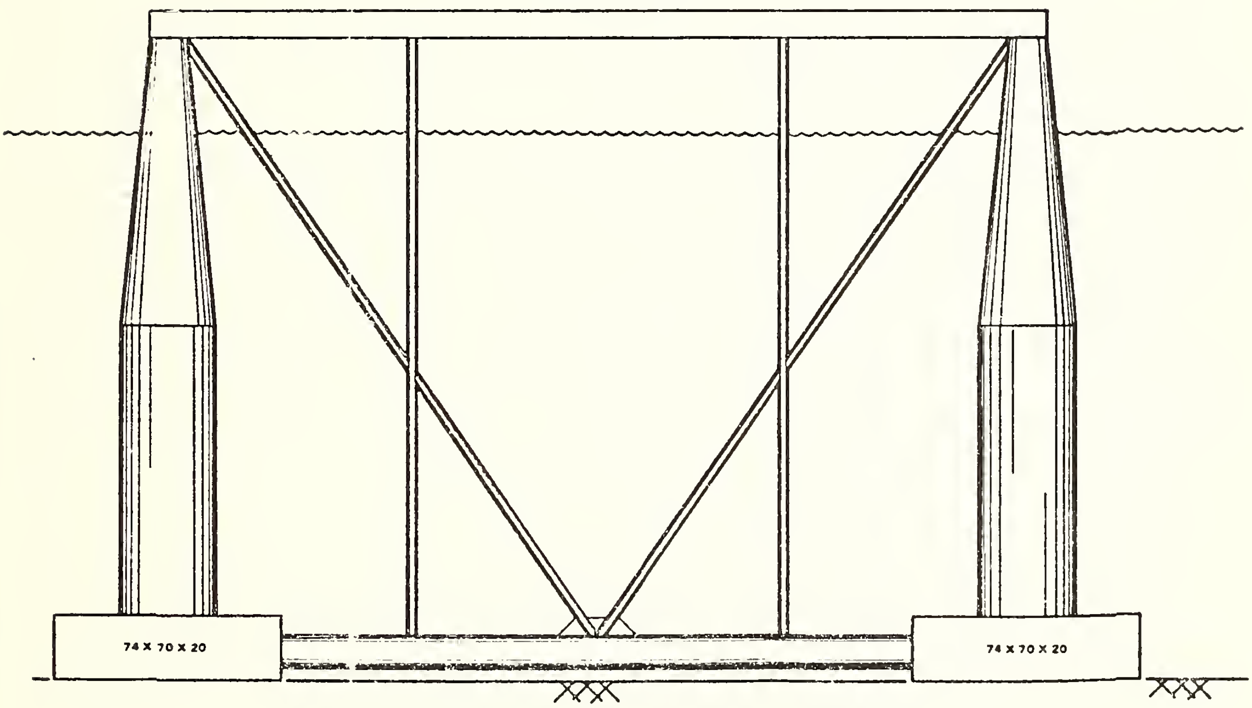


1957

Figure I-6

KERR-MCGEE "RIG 54"

TRIANGULAR SHAPE



1963

Figure I-7

some cases it is still necessary to use sand bags or oyster shells to protect locations where high currents are present. Another solution to the movement problem is to use spuds to hold the rig on location. The Offshore Company's "Rig No. 53," which has a dumbbell hull, uses spuds to give lateral support. Other units such as the California Company's "S-55," were designed with a streamlined hull to minimize wave forces and reduce scouring. There are shown in Figure I-4.

In 1956, the trend toward building long, rectangular (approximately 180 x 80 ft.) mobile units was reversed abruptly by Kerr-McGee's "Rig 46" Figure I-5 which used "bottles" at wide spacing to achieve stability in deeper water with no moving parts. This unit which measures 242 x 202 ft. was a very important development because it was also the forerunner of the semi-submersible. It was followed by the ODECO's "Margaret" Figure I-6 which has large, cylindrical bottles and a catamaran hull. Another bottle design, Penrod's "Rig 50", used spuds to give additional lateral support. The final development in this series was Kerr-McGee's "Rig 54" Figure I-7 which was included in the sketches primarily to illustrate its tremendous size. It can drill with a 25 ft. deck clearance in 175 ft. of water. This unit will probably remain the largest submersible since it does not appear practical to go to greater water depths with a submersible design. The success of the bottle-type unit is verified by the fact that approximately 14 of them have been built to date, including the recessed-pad conversions mentioned previously.

In studying the growth of submersible units it should be noted that the total number of submersibles, with the exception of the new semi-submersibles which can also sit on the bottom, has remained essentially constant since 1958. One reason for this trend is that, with the exception of Kerr-McGee "Rig 54", the regular submersibles are limited to a water depth of 80 ft. or less, while wildcat drilling has moved steadily into deeper water. Also, the jackup units have become very popular in the 75-150 ft. depth range due to their lower initial cost.

2. FLOATING DRILLING SHIPS AND BARGES

Vessels floating on the water surface have been used in offshore drilling operations since the late 1940's, immediately following World War II. Among the first vessels used offshore were U.S. Navy surplus ships and barges which were readily available, relatively easy to convert for drilling operations, and inexpensive to obtain.

The first application of floating vessels was in conjunction with fixed platforms, using the ship or barge as a tender. Only a part of the drilling equipment was installed on the vessel, with a large portion of the drilling equipment being placed on the platform which was permanently fixed to the seabed by pilings. U.S. Navy surplus YF (Yard Facility) barges, and LST's (Landing Ship Tank) were widely used in the Gulf of Mexico as floating tenders in support of fixed platforms.

In the early to middle 1950's several small vessels were outfitted with small coring or bottom sampling drilling derricks for use in the Pacific Ocean off California, and in the Gulf of Mexico. These vessels proved the feasibility of conducting drilling operations from a floating vessel, although their operations were generally limited to calm water areas and drilling shallow core holes or stratigraphic test wells.

As the search for oil and gas reserves moved farther offshore into deeper water, the cost of installing fixed platforms for exploratory wells increased substantially. When the prospective area proved to be non-productive, the cost of platform installation and removal to drill a dry hole, added to drilling costs, approached the economic limit. Other means had to be devised to continue the search for new reserves in the deeper waters.

One of the ways established to continue the search was to install all equipment required to drill a well onboard a floating vessel-either an ocean going barge or a ship. Thus the drill ship was born. In the late 1950's several vessels formerly used as tenders were converted to drilling vessels. The derrick hoisting equipment for the drill string, and the supporting structure for this equipment was installed onboard the vessel, making it independent of any structure permanently fixed to the seabed. Some of the vessels drilled over the side, others drilled from a centerline position. These units have proved to be effective in carrying exploration for new oil and gas reserves into new areas economically. Many of the vessels converted in the late 1950's and in the decade of the 60's are still in operation in various parts of the world.

With the experience gained in the early phase of offshore drilling from floating ships and barges, the need for improved vessels and equipment was apparent. Surplus vessels were not as readily available and were lacking in some of the desired capabilities for drilling vessels. In the 1960's, several new vessels were built in shipyards specifically for the purpose of offshore drilling. These barges and ships were designed from the keel up as drilling vessels. Specific arrangements of machinery areas, storage areas,

accommodations, mooring facilities and drilling and support equipment were incorporated. The aim was to increase water depth capability, improve sea-keeping qualities, improve stability characteristics, increase load carrying capability, and achieve efficient operations while drilling and also while in transit between drilling locations. These aims have been achieved quite successfully, and are being improved each year with new vessels being built for services in deeper, rougher areas of the oceans, worldwide.

Surface floating vessels have several inherent characteristics which are desirable and favor their continued use and development. Due to size, shape or configuration and close kinship to ordinary cargo ships, they can be built in many conventional shipyards of varying size and capacity without the requirement for special facilities. Construction time, costs and methods are comparable to those for other ships or barges and are generally economically favorable.

Mobility is a very desirable feature of these vessels. They can be relocated over substantial distances quickly and economically. Transit speed of 10-12 knots is relatively common, utilizing moderate sized propulsion plants of 4,000 to 12,000 horsepower, either as a self-propelled ship or as a towed barge.

Load carrying capability is another desirable feature. More recent vessels have loading capabilities allowing them to drill one or more wells at remote locations with little or no re-supply from other vessels or shore facilities. The supplies required can often be loaded in a port in a conventional manner, transported economically to a remote location, and utilized to drill one or more exploratory wells before requiring replenishment.

Since the drill ship or barge is not fixed to the bottom by permanent structures, it can operate successfully through a wide range of water depths, from very shallow to very deep. However, different sizes and types of these vessels are more suited to particular ranges of water depths, whether the controlling factors be physical or economic considerations.

Some disadvantages are also inherent in a surface floating vessel and tend to limit their operations to areas having generally favorable conditions. The vessels are highly responsive to wave action and can develop excessive motions in certain sea states which prevent conducting normal drilling operations, or in lesser sea conditions cause the operations to be inefficient or hazardous to personnel unless stringent safety precautions are taken including the rigging of life lines. Pitch, roll and heave motions are generally

directly related to wave and swell height and direction. When any of these motions become severe, operations must be curtailed unless compensating measures can be employed.

Wind and current forces can also be substantial and can hamper operations unless compensating measures can be taken. Mooring equipment for floating vessels exposed to wind, wave or current forces from unfavorable directions can be subjected to very large stresses under severe conditions which can prevent normal operations.

These disadvantages have led to employment of drill ships and barges in areas of the world or at times and seasons having sea and weather conditions favorable to their continued operation in the desired manner. The disadvantages have also led to the design and construction of improved vessels, with new and improved equipment, plus the development of improved operating techniques, all of which are intended to extend the capabilities of these vessels into more challenging areas.

Larger vessels have been built, and others will be constructed, having sizes and shapes particularly suited to drilling while remaining in a relatively constant position on the ocean surface with respect to the seabed. Special mooring arrangements have been developed to permit surface vessels to change heading to minimize motions of the vessel. Having the capability to head the vessel in the most favorable direction, considering the effects of wind, waves and current, permits continuing drilling operations in a more severe environment.

Some vessels have been specially reinforced and strengthened to permit operations in areas having some ice accumulations in the ocean. Several vessels have been equipped with special propulsion and thruster units allowing them to remain on location without anchoring. This dynamic positioning equipment can be computer controlled to keep the vessel in the correct location and on a favorable heading in very deep water under varying wave, wind and current conditions. Special equipment has been designed, built and installed to help compensate for vessel roll, pitch and heave. Such equipment further extends the capability of drill ships and barges to continue operations under adverse conditions.

The trend in offshore exploration clearly indicates that the Oil Industry must extend its search for oil and gas into water depth beyond the continental shelf. The need for additional oil and gas reserves and the belief that sizeable reserves could indeed exist in greater water depths have encouraged interest in deepwater exploration. This deepwater exploration

has resulted in the need for new techniques and tools for water depths of 2,000 feet and greater.

The major limiting factors to existing offshore exploration drilling are the anchoring capability and the underwater drilling equipment system.

The following describes the SEDCO 445, a Dynamic Stationed Drill Ship, specially designed and equipped with the capability of anchoring in unlimited water depths. The use of new techniques such as Electro-Hydraulic (BOP) Blowout Preventer controls; accoustical re-entry; and riser buoyancy increase the capability of the underwater drilling equipment systems to something greater than 3,000 feet.

The SEDCO 445 drilling ship is a typical self-propelled ship, dynamically stationed when on location in deep water, and self-sufficient for several months. Accommodations and laboratory space are provided for drilling, electrical logging, mud logging, diving, petroleum engineering, and geological and management services, all of which are designed to be independent of shore support. However, for emergency supplies, timely restocking, personnel access and safety stand-by, the drilling unit is provided with a helideck and is accompanied by a large crew-standby boat and workboat. It employs, in addition to measuring its position with a high degree of accuracy, propellers capable of exerting thrust in controlled directions and a system for activating propellers to rectify deviations from a predetermined position.

Dynamic stationing for large vessels has only recently become feasible as a result of advances in directional propulsion and position measurement systems, and greater understanding of the behavior of vessels at sea. A vessel equipped with dynamic stationing can head into the waves thereby reducing motion. The SEDCO 445 with its dynamic stationing is expected to hold position and operate in 50 knot winds, 12 foot significant waves and 1.5 knots current, all acting on the vessel simultaneously and concurrently.

The SEDCO 445 is designed to hold location within 100 feet of a well with guidelines connected, heading into 70 knot winds, 3 knot current and 30 foot significant waves. The ship can survive the 100 knot wind, 70 foot significant wave.

The ship is a molded hull type, all-welded construction, self-propelled and complies with all requirements of the American Bureau of Shipping

and SOLAS*. United States Coast Guard and United States Public Health Service requirements have been followed. General characteristics are as follows:

Length Overall	445 feet
Width	70 feet
Depth	32 feet
Normal Draft	22 feet
Underway Speed	14 knots
Displacement at 20 foot operating draft	11,700 long tons
Displacement at 25 foot operating draft	15,100 long tons
Variable Load	6,500 long tons
Period of roll: (Ship's natural period of roll)	12 - 13.5 secs.
GM Range	6.9 - 8.3 feet

The drill ship's equipment is installed on three levels within and above the ship's hull. Enclosed within the hull are pumps, tanks, storage, ship support equipment, ship and drilling power generation, and equipment maintenance and work areas. Operating displacements are between 11,700 and 15,000 long tons with a variable cargo load of 6,500 long tons.

Above the ship's main deck and amidship, the drilling derrick has been elevated to provide sufficient space for handling the subsea blow out preventer riser, etc. The moon pool opening is 22 feet I. D. Three cranes have been installed above the ship's main deck to facilitate equipment handling at the rig floor.

The ship's power plant consists of two basic systems - a main power system and an auxiliary power system - with a bus tie between the two systems to provide for the event of complete failure of the auxiliary system. The main power plant includes five diesel-driven alternators each rated at 2100 KW continuous, and provides power for the three major modes of operation of the drill ship: (1) propulsion while in transit, (2) normal positioning plus drilling, and (3) positioning, maximum thrust required, no drilling. Auxiliary power is provided by two diesel driven alternators, each rated 1050 KW continuous each of which is capable of handling the full design auxiliary load.

*Safety of Life at Sea

The ship power is 5 S16-E 4 GW - 20EMD 2100 KW, 4160 volt A.C. generators to provide power for the main propellers, stationing propulsion units, drawworks and other drilling services. The generators totaling 10,500 KW supply AC power to a common bus bar from which the voltage is reduced by transformers to 600 volt. Baylor Thyristor systems are used to convert to DC and control a variable voltage power supply to the various DC motors (32 in total).

In addition there are (2) S-12 EGW-EMD A.C. generators for general ship service and a 350 KW emergency generator.

The ship is equipped with all required auxiliary systems for control, navigation, operation and safety.

Main propulsion is provided by a total of 9,000 horsepower from 12 DC motors on two 13 foot diameter, 4 bladed stainless propellers. This system is capable of driving the ship at a speed of 14 knots.

The ship is provided with a dynamic stationing system which holds the ship on location for offshore drilling operation in water depths from 200 feet to 3,000 feet while drilling to depths of 20,000 feet below the ocean floor. The system is capable of holding the ship over a pre-determined point (6% of water depth) and of maintaining drilling operations through 50 knot winds, 12 foot significant waves, concurrently with a 1 1/2 knot current. The system consists of acoustical and taut wire position reference systems, position process controllers and eleven 800 HP thrusters plus main propellers. The system design provides 100 percent redundancy. Similarly , the stationing system is capable of holding the ship closely to a pre-determined percent of water depth in most extreme conditions.

The system has two computer centers which continuously check each other and which switch over or signal an alarm if one malfunctions. A digital tape recorder system is provided which records pertinent dynamic stationing data so that any malfunctions can be analyzed. An onboard analysis system is also provided so the digital tape can be processed.

There are six methods of position reference checking. Provided are two RS-5 acoustic position indicators with six hydrophones; two taut wire methods (one over the side and one on the guide line); two riser angle indicators, either of which can be moved to alternate positions (top or bottom of riser). All these methods feed into the computer and are capable of being used to position the ship or to check the other systems.

The thruster system consists of eleven thrusters and the main propulsion screws. The thrusters are positioned to provide the best ship movement capability so the ship can always head into the worst environmental conditions.

Dynamic Stationing control is provided by an automatic station keeping (ASK) system specifically designed for position control of offshore drilling vessels. The system provides precise, automatic control of the position and heading of the vessel over long periods of time through automatic control of the vessel's propulsion system. The system measures the vessel's position by means of an Acoustic Position Indicator which provides vessel-position information relative to a single acoustic beacon placed near the sea-floor drilling position. Heading information is provided by the vessel's gyrocompass. Control orders to the propulsion system, in response to deviations from desired position and heading are automatically provided by a digital computer. To ensure precise, smooth control at minimum thrust, the automatic control program is specifically tailored to the vessel and its propulsion system by a dynamic simulation analysis.

The system is composed of two acoustic position indicators, two digital computers, two hydrocompasses, automatic switching equipment, thruster control interface, and an operator control and display console.

The system provides sensor and computer monitors to effect an automatic transfer from the on-line computer to the standby computer in event of malfunction. The standby computer is continuously updated by the on line computer to allow for smooth, bumpless transfer from one to the other.

Table I-3 tabulates a number of drilling ships and barges with their principal characteristics. Cuss I and LCM Class were converted Navy vessels, while the others were built as drillships from the keel up. In 1962, the Glomar II was the first drilling ship built as new construction. This class was followed by the Glomar Sirte Class in 1965 and the Glomar Grand Isle Class in 1967. A modern drillship, the Discover 534, presently under construction is illustrated in Figure I-8.

Pollution control equipment required to be employed in floating vessel drilling operations includes: a drill cuttings washing system to assure that no oil, or drill cuttings sand, or other solids containing oil, is discharged into the sea (hauling of oil wet cuttings to shore for processing and disposal is utilized if more practicable); drain collectors and gutters to collect all feasible oil-contaminated rig-area washdown fluids; and

DRILLING SHIPS AND VESSELS
(Typical)

Ship	Length Beam, Draft	Displacement (Tons)	Rated Depth (Feet)	Draft Loaded (Feet)	Cargo Capacity(LT)	Centerwell (Feet)
GLOMAR GRAND ISLE CLASS						
Glomar Grand Isle	400x65x20	11,000	25,000	20' 10"	6203 L. T.	20' x 22'
Glomar Conception	400x65x20	11,000	25,000	20' 10"	6203 L. T.	20' x 22'
Dynamically Positioned Glomar Challenger	400x65x20	11,000	25,000	20' 10"	6203 L. T.	20' x 22'
GLOMAR SIRTE CLASS						
Glomar Sirte	380x64x19	9,550	25,000	19' 10"	5650 L. T.	20'6"x24'
Glomar Tasman	380x64x19	9,550	25,000	19' 10"	5650 L. T.	20'6"x24'
Glomar North Sea	380x64x19	9,550	25,000	19' 10"	5650 L. T.	20'6"x24'
GLOMAR II CLASS						
Glomar II	268x58x15	5,500	25,000	16' 1"	3550 L. T.	22'x24'
Glomar III	268x58x15	5,500	25,000	16' 1"	3550 L. T.	22'x24'
Glomar IV	268x58x15	5,500	25,000	16' 1"	3550 L. T.	22'x24'
Glomar V	268x58x15	5,500	25,000	16' 1"	3550 L. T.	22'x24'
CUSS I						
Cuss I	260x58x10	3,600	15,000	10'91/2"	1870 L. T.	20'6"x24'
LSM CLASS						
Western Explorer	204x42x8	1,500	6,000	8'	595 L. T.	10' Dia.
Rincon	204x34x8	1,300	6,000	8'4"	525 L. T.	10' Dia.
LaCiencia	136x24.5x11.5	250	1,500	9'	52 L. T.	

TABLE I-3

Discoverer 534

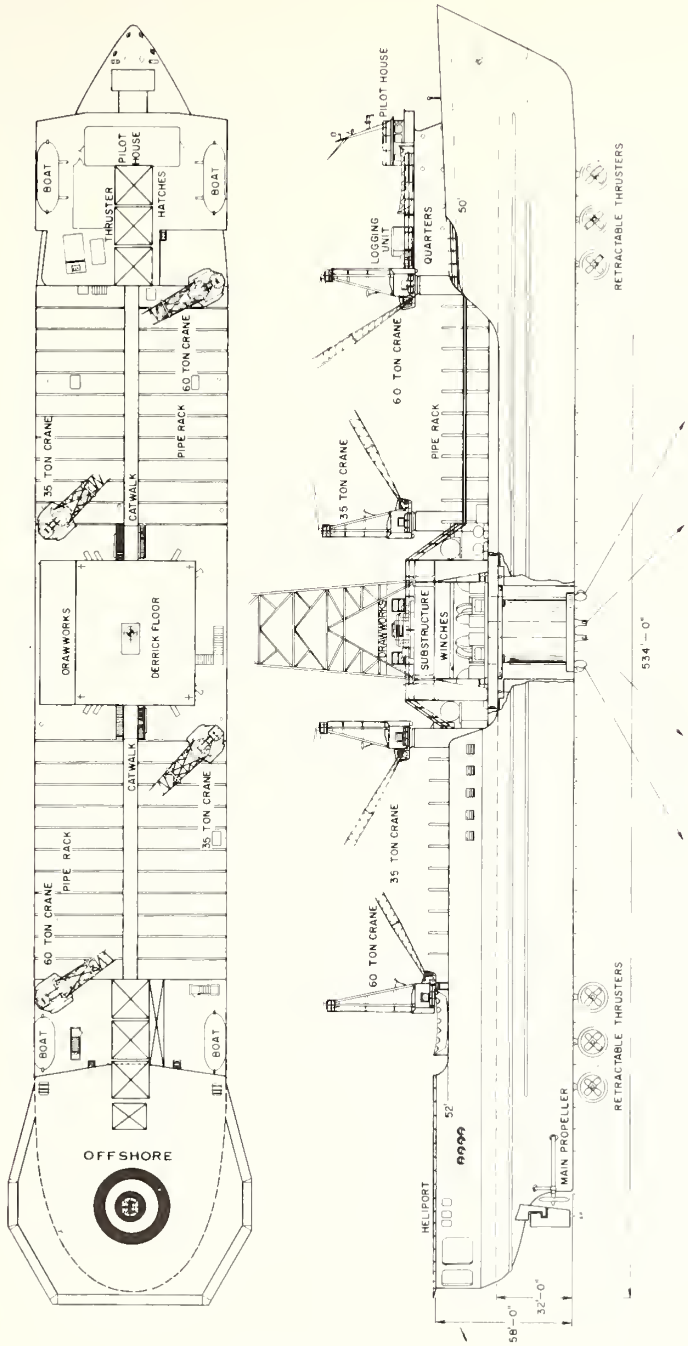


Figure I-8

tanks for storage of liquid waste water until treated for disposal or transferred to a shore facility for processing. Trash and waste material is accumulated in special containers, transported to shore and hauled to an approved refuse site. Biological wastes from the crew quarters are treated and disposed of in strict compliance with Geological Survey and Coast Guard regulations. Ocean dumping of waste materials, or debris is not permitted.

3. JACK-UP DRILL UNIT

A major design type of mobile drilling unit is the jack-up or self-elevating drilling unit. This type or class of drilling unit has been developed for extensive use in offshore operating areas since the mid 1950's.

The jack-up unit evolved from the DeLong docks. These docks were developed for use in remote areas where heavy construction equipment was not available or where it was necessary to install a dock quickly. The first jack-up unit was Magnolia's "DeLong Rig No. 1". This unit was built in 1950 and installed permanently on its first location in 1953. The first truly mobile unit (in the sense that it was used to drill at several locations) was the DeLong - McDermott "No. 1" which was later purchased by the Offshore Company and named "No. 51." This rig has a hull whose dimensions (230 x 70 x 8.5) were similar to those of the early submersible units.

In 1955, the Royal Dutch/Shell Group built a mobile jack-up rig for use in the Persian Gulf off Qatar. This unit was carried to the drilling location on two barges. After the legs were extended and the unit raised to drilling position, the barges were removed. One problem with this arrangement is that the platform is in a vulnerable position when the legs are set and the barge hull is subjected to wave action. Another unit using somewhat the same principal was built in 1954. Glasscock Drilling Company's "Mr. Gus I" was the first mobile unit designed for water as deep as 100 ft. under hurricane conditions. "Mr. Gus I" used a barge-type hull to carry the upper deck to the location in an elevated position. After the piles were jacked into the soil, the barge was lowered to bottom to give additional support. As a point of historical interest, this unit was originally built as two platforms in order to improve stability and overcome problems of positioning the platforms with respect to each other.

One of the problems associated with the early pile-supported jack-up units was that of excessive leg penetration in soft soils. At least two of these units have tipped over as a result of apparent soil failures while preparing to move off location. One way of counteracting this difficulty was to add large diameter "cans" near the lower end of the cylindrical legs.

This idea was first tested on the Offshore "No. 51" rig. The Offshore Company's "No. 52" was built with spud cans in 1955. A number of jack-up units are using spud cans today.

The jack-up unit basically consists of an upper or main hull, elevating or jacking mechanisms, support legs and bottom bearing structures. The upper or main hull contains the drilling and other required machinery and equipment, supports the elevating or jacking mechanisms, contains the crew quarters, provides storage space for the required drilling supplies and crew provisions, supports a helicopter landing area and affords a base for the installation of materials handling equipment such as cranes and derricks.

The elevating or jacking mechanisms consist of a leg support and guide structure and the jacking mechanism. The jacking mechanisms utilized extensively in the offshore jack-up units (operated successfully in the last twenty years) are basically and generally of the electro-mechanical type, the electro-hydraulic type and the hydraulic-mechanical type. The jacking mechanisms are generally built into and supported by the leg support and guide structures. On some classes of jack-up units, this entire structural assembly is designed with a tilting or angle change feature which enables the legs to be positioned on the bottom at a slant angle with respect to the vertical.

The support legs for mobile jack-up units are generally constructed of either large diameter singular tubular members, or an open truss structural member comprised of structural chords and cross-bracings. Designs with varying numbers of support legs have been safely utilized in almost every offshore area of the world employing from three to eight legs and of lengths varying to suit the water depth requirements.

The various bottom bearing structures successfully utilized on jack-up units consist of basically either a single large mat structure to which all support legs are afixed or individual can tanks afixed to the bottom ends of each individual leg. The mat structures can be designed as one barge shaped unit or can be designed as an integral grid-work type unit. The individual leg spud cans are generally cylindrical in cross-section and have either a sloping or point shaped bottom end.

Jack-up units are designed to be moved to offshore drilling sites either by towing by seagoing tugs or offshore service vessels, by means of installed propulsion units or by a combination of both methods. They are designed to move to drilling locations with the support legs in a fully elevated position firmly secured in the leg support structure, by structural guide supports. The upper or main hull generally provides the buoyancy

to float the jack-up unit and its equipment to the drilling location although the bottom support mat or the spud cans also contribute to the overall buoyancy of the system.

At the location, the support legs are lowered from their elevated position by means of the positive control and fail-safe jacking mechanisms until the bottom bearing structure contacts the sea floor. In the case of the mat type units, the mat rests upon the sea floor with generally small penetration of the sea floor itself. In the case of the spud can type units, the tips or points of the cans actually penetrate into the sea floor to develop the required bearing support.

After the flooded bottom support structures have contacted the sea floor, the upper or main hull is jacked-up on the legs to clear the sea surface and then a required amount of preload or test weight of sea water is pumped aboard to securely set the bottom bearing structure and conform the stability of its sea floor fixity. After the preload operation, the main hull is elevated above the sea surface to an elevation where no contact with the maximum anticipated sea conditions will be experienced. When that level is reached and the desired air gap is achieved, the legs are locked into position in the support guides and elevating mechanisms. The jack-up unit then becomes, in effect, a fixed platform from which all conventional drilling and well remedial operations can be performed.

Other applications of jack-up units have included derrick barges, work barges, oil and gas separator platforms, and tanker loading islands.

Major advantages of jack-up units are that:

1. They provide a fixed platform.

2. The large buoyant members are not subjected to wave action when the rig is in place.

3. Rigs seldom move off location during storms (although Penrod's Rig 52, equipped with mat, moved 50 miles during Hurricane Carla without suffering severe damage).

The development of the jack-up designs being operated and built today is the result of the offshore industries effort to employ the utmost in the latest technical testing, computing and analytical methods available with a continuing correlation with the vast operating experience gained by the utilization of this type design in the last twenty years.

The remarkable performance of the self-propelled jack-up drillship is of particular note. One such vessel is the 'Offshore Mercury." Her seaworthiness was demonstrated on a 6,800 mile maiden voyage across the Atlantic (Scotland to Argentina). During the two month trip she averaged 6 knots through winter gales that created 50 foot waves. Once on location, this highly functional rig was able to lower her legs in 8 foot seas to jack-up to operating height in 25 minutes. The following description applies to the "Offshore Mercury" as a typifying the latest in jack-up units.

The relative merits of the self-propelled drillship vs. the jack-up unit have often been debated in the offshore oil industry. Generally, it's acknowledged that once a jack-up unit is on location and elevated to operating height above the water, it is virtually immune to wave action and can carry on drilling operations in almost any sea state. This advantage, however, is offset somewhat by the difficulties involved in mobilization. The jack-up makes an ungainly and expensive tow, often requiring the services of two tugs in moving from one location to another.

On the other hand, the self-propelled drillship is largely independent of the burdensome expense of tugs, and can change locations and commence drilling quickly and efficiently. This economic leverage, however, may be greatly diminished in some areas. The large water plane area of the drillship's hull makes it considerably more responsive to waves than the bottom-supported jack-up; heavy seas may curtail drilling operations.

The Mercury uses "floating type" jacks which largely overcome the most difficult problem involved in jacking a heavy hull up out of the water. Just prior to the touchdown of the legs onto the bottom, the vessel is responding to some degree to waves or swells by rolling and pitching at its normal period. This movement can cause one of the legs to slam into the bottom, and the shock loading can damage the structure.

The longer the time of transition from "sea support" to "bottom support," the greater the likelihood of leg damage.

Offshore engineers overcame -- or at least greatly minimized -- this problem by devising a means of virtually decoupling the hull and the legs during touchdown. This is accomplished in the following manner: while the legs are in the air, they are supported by jacks bearing against the bottom plates of the jack house structure. When the legs touch bottom, the jacks must literally climb about 6 feet up the legs to reach the top of the jack house before they exert an upward force on the hull.

As the eletrohydraulic jacks engage the top of the jack house, any possible shock loading is minimized by shock absorbers. As the jacks bear against the top of the jack house, the hull is lifted.

The triangular legs, which are constructed of heavy tubular steel, are made up of three sections. The longest section (which is also the minimum length of the legs) is 260 feet long, and there are two 48 feet leg extensions which can be added to it to increase the overall length of the legs to 308 feet or 356 feet.

During long voyages, the leg extensions are stowed on deck, and the 260 feet sections are extended above the ship with their bottoms flush with the bottom of the hull. S pecial reinforcement enables them to withstand forces that may be produced by the motion of the ship in the water.

Because the Mercury is a hybrid vessel, her command changes on different occasions. When she is afloat, the captain is in command. When she is being jacked-up out of the water or lowered, the Jacking Department is in charge once she is in a position to start drilling, the Drilling Department is in charge.

The ship characteristics of this unit are:

Hull dimensions	276' x 130'
Hull depth	22'
Draft	15'
Light ship weight	9,350 LT
Propulsion	Twin screw, 4000 HP each
Speed	8.5 kts. (calm water)
Range	7,500 miles
Fuel oil (98%)	1,260 LT
Legs (4)	355' - 7" each with extension
Drill pipe (5")	14,000'
Operating water depth	maximum - 250' minimum - 22'
Quarters	72 persons
Jacking speed	60'/hr up 120'/hr down

Other characteristics can be seen in Figure I-9.

Offshore Mercury

SELF-PROPELLED, ELEVATING DRILLING SHIP

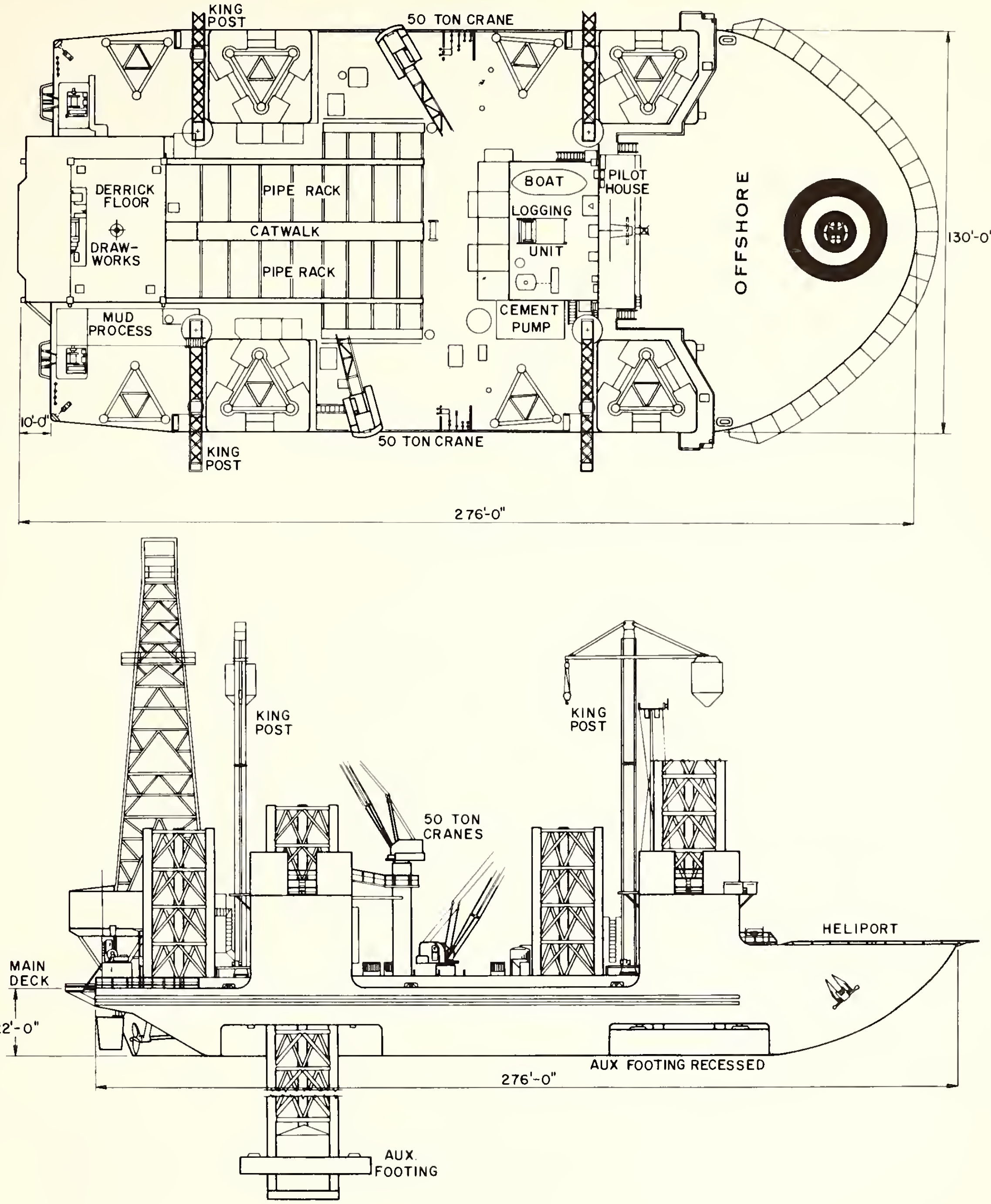


Figure I-9

4. SEMI-SUBMERSIBLES

The great trend today is in semi-submersibles. This comes as a response to the trend toward deeper water and rough seas.

The semi-submersible type platform gains its main source of buoyancy from hulls which are submerged below the surface where wave action is less severe. Stability is provided by vertical columns which pierce the water plane area.

An advantage of this particular configuration is that it lends itself to definitive structural analysis. Stresses can be determined through computer analysis to determine such structural factors as fatigue, notch toughness and crack propagation.

Development of the semi-submersible, or column-stabilized platform concept, received great impetus when this type was selected for the Mohole project, in which drilling was to be performed in very deep water. The design of this type of vessel is primarily a problem of obtaining an optimum balance between four conflicting factors, i.e., stability, structural strength, motions in waves, and propulsion characteristics. Desirable qualities are light weight, to allow high deadweight capacity with adequate stability; great structural strength; minimum waterplane area; high wave transparency to minimize motion; and low underwater resistance to allow dynamic positioning with reasonable power. In addition, the upper hull must be sufficiently high above the water surface to maintain safe clearance above wave crests from the standpoints of structural integrity and motions.

The four principal factors enumerated are almost incompatible. Any three can be satisfied easily, but addition of the fourth requires a delicate compromise. For example, by setting aside the requirements for minimum motion in waves, adequate strength could be built into the upper hull to ensure structural integrity and increase the waterplane area as necessary to provide stability; however, this would increase the motion of the platform in a given sea.

By setting aside the requirements for low underwater resistance, bracing could be added between the lower hulls to provide strength with light weight, small waterplane area and, therefore, favorable motion characteristics could be maintained; however, propulsion requirements would add to the

power required in propulsion motors and diesel-generator sets, thereby increasing construction and operating costs. Attaining the proper design balance is like finding the "window" in space in launching a satellite into orbit.

In very deep water, where semi-submersible, column-stabilized platforms or single or catamaran-hull floating rigs are used, the principal design problem is mooring. An anchoring system becomes increasingly heavy and expensive as water depth increases. Improved design now permits anchoring depths to 1,000 feet to 1,500 feet. Beyond such depths, it becomes necessary to use dynamic positioning propellers with a sophisticated control system.

Description of the three typical semi-submersibles follow:

> Sante Fe's Mariner II, is a typical small semi-submersible. It has an overall length of 270 feet and overall beam of 106 feet and a height to the Texas deck of 42 feet. Displacement at drilling draft is 8,300 long tons. Mariner II carries 11,100 barrels of drill water, 2,730 barrels of ship service water, 3,360 barrels of fuel, 50 barrels of potable water, 1,250 barrels of liquid mud, 5,600 sacks of bulk material in a sack storage area of 70 feet by 35 feet. It has quarters for 80 men. Mariner II can drill in water depths from 60 to 1,100 feet in 15 foot waves and can drill to depths of 20,000 feet.

> Penrod 71, is a typical medium size semi-submersible. Penrod 71 hull dimensions are 288 feet by 216 feet by 138 feet. It can drill 30,000 feet at water depths of 1,000 feet. Penrod 71 can carry 80,000 cubic feet of bulk mud 1,700 barrels of liquid mud, 7,200 barrels of fuel, 4,200 barrels of drilling water and 3,000 barrels of potable water. This unit is designed to operate in 35 foot waves and survive in 80 foot waves (100 year storm).

The following is a detailed outline of the SEDCO 700 a typical large mobile semi-submersible, constructed with Title XI financial aid. Figure I-10.

General Description:

> The basic structure of the vessel consists of two barge-type lower hulls, each with two vertical cylindrical stability columns which together with a system of tubular trusses, support a rectangular working deck. On this deck are mounted a two-story accommodation deck house, a helicopter deck, an enclosure for drilling machinery, a pipe rack and a substructure to support a drilling mast.

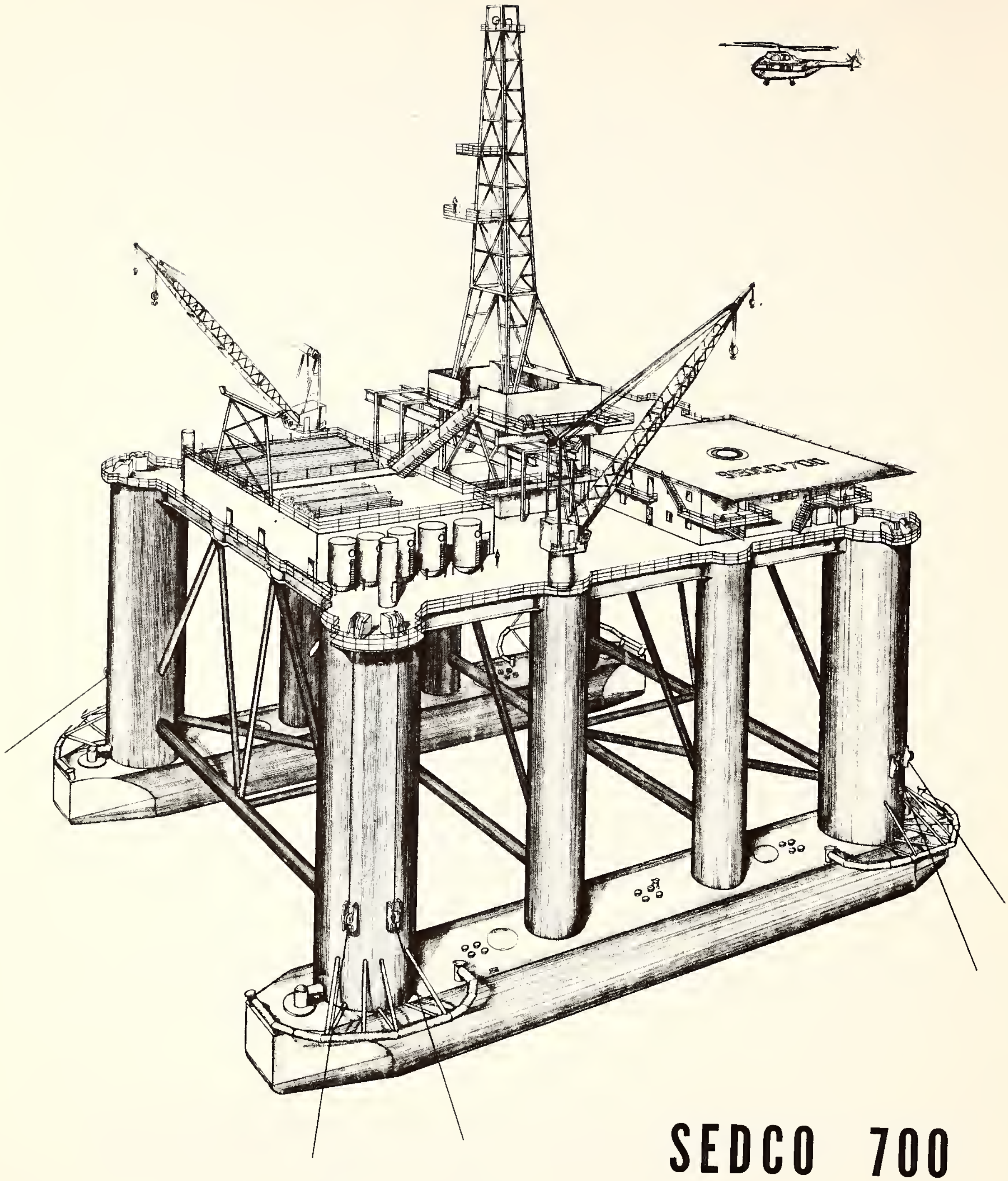


Figure I-10

Dimensions Overall:

Length	300' fore and aft ends of anchor racks
Width	260' outboard ends of anchor racks
Height	305' top of drill mast to bottom of keel
Lower Hulls:	LOA = 295', Beam = 50', Depth = 21'

Superstructure consists of:

a) Quarters house, 70' x 20' high; accommodations for 120 persons.
b) Engine house 86' x 70' x 20' high housing drill equipment and machinery.
c) Helicopter Dk., 70' x 70' with 5' wide perimeter net, elevation 150'.
d) Mud house, 75' x 110' x 17' high housing piping, pumps and mud tanks.
e) Substructure, support for derrick, deck 52' x 50'; elevation-170'.

Anchoring systems - Eight 30,000 # Anchors with 4,000 feet of 3" chain each.

The drilling draft is 70 to 90 feet, the deeper the draft the less the motions. Limiting sea condition for the 90 foot draft corresponds to a maximum wave height of about 50 feet. This rig is designed to survive in 100 foot waves it can drill to 25,000 feet in water depths up to 800 feet.

The completed light weight of the vessel as determined by a stability test was 13,143 long tons with a vertical center of gravity of 63.1 feet above the base line. Approximately 8,000 long tons is steel structure.

5. MOBILE WORKOVER RIGS

An oil or gas producing well requires certain maintenance after it has been in operation over a period of time. Oil or gas from the well include other materials such as sand, wax sulphur etc., that tend to plug the well and slowly decrease production to the point where output will eventually cease entirely.

A routine method of cleaning the well of foreign matter is to periodically force a weight, attached to a wire, down through the bore hole by means of water pressure. The weight, known in the industry as a "pig", is then brought up thereby dispelling the material tending to block the well. This

operation is known as workover by wireline and prolongs the necessity of employing the workover rig until such time that the wireline operation is no longer possible.

In order to improve or restore production from the well a reaming operation is performed which is carried out by positioning a drill derrick over the well and lowering a drill bit down through the original bore hole thereby removing the blockage and restoring the well pipe to its original diameter.

Other operations of the workover rig include deepening of the well if necessary and replacing deteriorated well head equipment such as safety valves, piping etc. Appropriate blowout prevention equipment is used in all workover and servicing operations. Several methods of redrilling the bore hole are employed, however, the principle is the same as when the original well was drilled. Typically a drilling derrick and rotary table are transported to the well by a derrick barge and erected on the platform in place of the production equipment.

Some mobile workover rigs are specifically designed for operation on the satellite structures of multiwell complex. Newer units are capable of either working over the satellite wells or are able to skid their entire derrick and rotary table from the deck of the vessel onto a multiwell platform and then stand by as a tender while the operation is taking place. Many of these units are capable of drilling in excess of 12,000 feet and are often used for exploratory drilling.

The latest rigs in the field are the specialized mobile units, usually jackups. One such rig "The Hustler" is shown in Figure I-11. These units are designed for optimum mobility, speedy rig up and rig down. They have the advantage of being able to work both on platforms and over satellite wells by virtue of cantilevered rigs. Higher priced on a day-rate basis than the lightweight platform rigs, the mobile units have an economic advantage in that most can fit themselves to the configuration of a platform and there is a minimum removal of production equipment from the structure while workover operations are being carried on.

It is estimated that in 1973 there were some 400-500 major workovers performed offshore. This number is expected to increase as the older offshore wells, now ranging in age from 13 to 20 years begin to encounter problems that wireline operations can no longer solve.

Hustler

SELF-CONTAINED JACK-UP PLATFORM

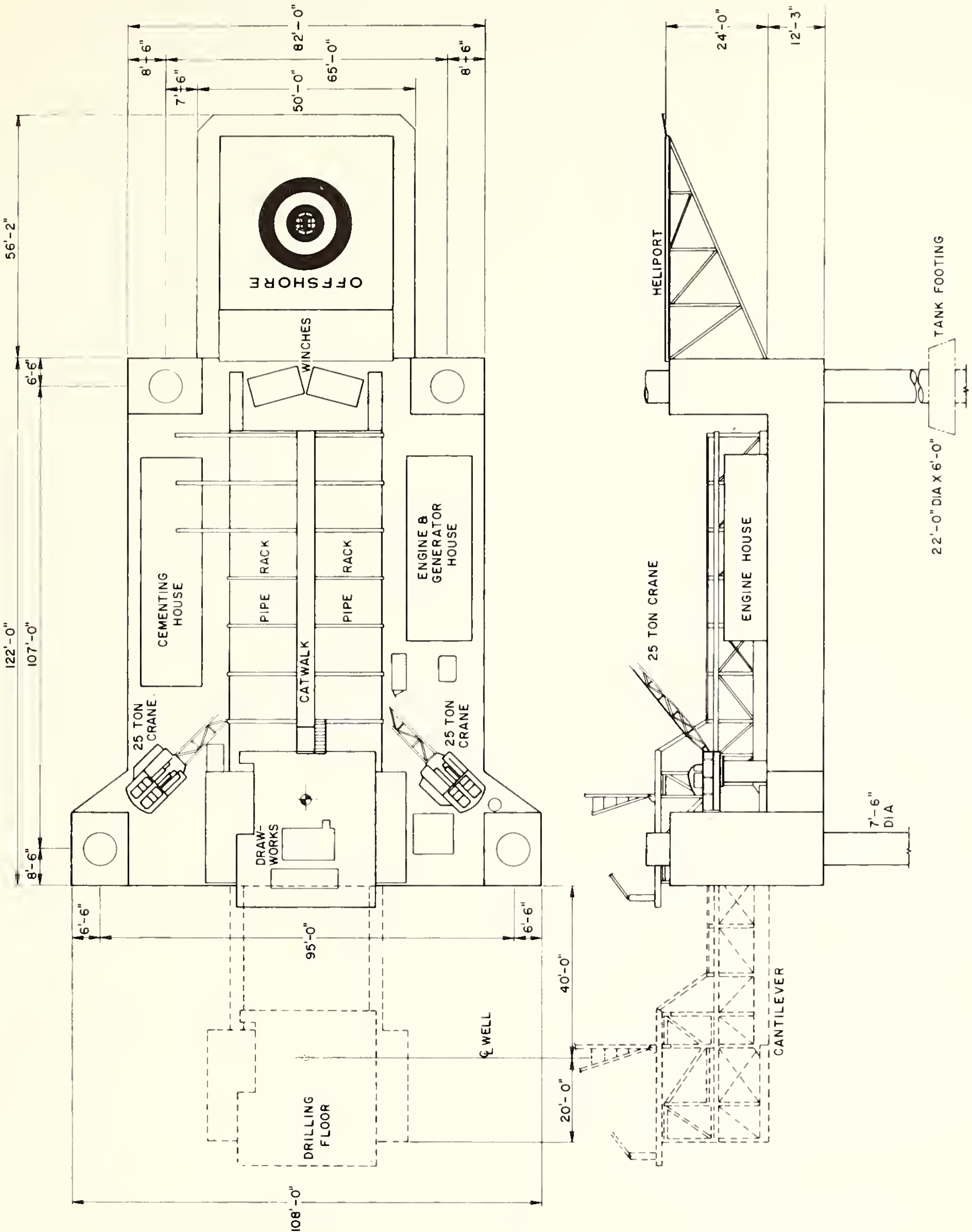


Figure I-11

Cost factors in working over a well are so critical that both contractors and operators are seeking ways to cut cost of workovers. This is becoming increasingly important in building mobile units as offshore wells move into deeper water. Although most of the wells at present are in water less than 100 feet future rigs will have to be able to work in deep water also.

6. OFFSHORE SERVICE VESSELS

At the beginning of the industry, in 1947, and for the first few years of its growth, essential water craft came first from the traditional Gulf Coast fishing fleet. The first such mariners to begin moving men and material from shore to the offshore rigs were seasoned Gulf of Mexico commercial fishermen who knew well and respected the challenging waters off the Louisiana and Texas Coasts. From the marginal beginning using war surplus craft shrimp trawlers, and converted pleasure craft, today the petromarine fleet is composed of many types; crew boats, utility boats, supply boats, inland and oceangoing tugs, geophysical and oceanographic vessels, and specialized barges of various types. Each is designed for a specific purpose in the offshore scheme of operations. This fleet is today, a sophisticated array of logistic support vessels used to move the men, machinery, supplies, and the rigs themselves, needed in the search for offshore oil and gas.

The marine transportation industry has evolved to a fleet of over 2,700 vessels with a replacement value in excess of $4 billion. These vessels have been designed by naval architects and marine engineers to meet the growing demand to serve the industry throughout the world.

The offshore boat building industry, as we know it today, took its first step in the coastal regions of Louisiana with the introduction of steel hulled craft, powered by diesel engines. Many of these boats are still performing the services for which they are originally designed.

The next step in offshore boat development, and a significant one, was the introduction of lightweight welded aluminum hull construction. This development was also pioneered in the Louisiana coastal areas. Aluminum construction has proved to be highly reliable and is used extensively throughout the industry.

Inasmuch as offshore oil and gas logistical support vessels come in numerous sizes and configurations to meet industry needs, only a representative number of the basic types have been selected to illustrate their utilization as follows:

a. Tugs
b. Supply Vessels
c. Crew Boats

a. Tugs

The typical all-ocean tug is used for heavy tows. Diesel engines provide 4,000 to 6,000 HP for a 120' to 140' all ocean tug designed for long range towing of drilling rigs; derrick, pipe-laying, dredgé, and material barges. Most tugs in this service have a range of 6,000 miles with a speed range of 6 to 13 knots. This type vessel can move almost any size equipment anywhere in the world. Twin screws provide excellent maneuverability and the tug is fitted with the latest navigational, radar, and communications equipment. All quarters are air-conditioned. Depending upon service requirements, crew numbers usually between 8 and 12.

A specialty of particular tugs, includes anchor handling for the foregoing equipment. This involves the break-out and relocation of the heavy anchors and cables used in mooring the mobile units including drill ships, jack-ups, the submersibles and semi-submersibles. Anchor handling is also required for the movement of lay and bury barges.

Depending upon outfitting requirements of owner, cost of this type vessel ranges between 1 1/2 to 2 million dollars.

b. Supply Vessels

It is within the area of supply vessels that the offshore industry has seen some of the most dramatic development to come about in the last five years. The early utility vessel of 120 to 135 feet is being replaced by the current series of supply type vessel now in sizes up to 220 feet in length. Although most are still being built under 300 gross tons all current construction and most of the last five years has found the vessels built under the standards prescribed by the United States Coast Guard for cargo ships which are not enforced by that agency for this size vessel. Depending on the area of operation, they are manned with five to nine man crews, all licensed or certificated for their position.

Following the rules for cargo ships they may carry 12 persons in addition to the crews.

There are nearly 300 American supply vessels currently operating. Their service includes the carriage of cargoes in capacity ranging from deck loads of 300 to 600 tons. Equipment, general stores, mud, cement, drilling water and fuels constitute the average cargoes.

The newer series designed for use with mobile drilling units like the one shown in Figure I-12 includes towing capability which has extended their adaptability and accounts for the increase in size, usefulness and deployment throughout the world. They are in wide use in areas where extreme weather and sea conditions are fairly routine, such as the North Sea, and capable of full rig supply, anchor pulling, and rig towing. These vessels are of steel construction, twin screws, 3,000 to 8,000 HP, and some are equipped with controllable pitch propellers and kort nozzles. Some are ice-strengthened and have operating speeds of from 12 to 16 knots. These vessels, similar in design to the smaller size supply vessels, are suitable for operating anywhere in the world and capable of ocean towing. Fuel oil capacity is 90,000 to 130,000 gallons. They have a capacity of stowing 2,000 to 6,000 cubic feet of dry bulk cement. Air conditioned quarters are built to accommodate from 20 to 30 men, but usually are operated with a 10 to 16 man crew depending on the operational areas.

The cost of these vessels, depending on owner's outfitting requirements, will vary from 2 1/2 to 5 million dollars.

c. Crew Boats

By and large crew boats are all under 100 gross tons and are found in lengths from as small as 20 feet to the largest, the current series, now at about 120 feet in length. Their size dictates their area of operation from one and two man passenger service in the swamps and bayous of Louisiana to those that carry 150 passengers 150 to 200 miles offshore in the Gulf and other offshore areas of the world.

There can be no accurate tabulation as to the total of crew boats so employed throughout the world. The generally accepted figure is just under 2,000 such vessels. The older, less sophisticated are in fact converted fishing vessels and trawlers of wood and used exclusively inshore. These vessels carry less than six passengers and are uninspected for that service by the U.S. Coast Guard, however, because they carry passengers, the operator must hold a Motor Boat Operators License.

All are diesel propelled and virtually all offshore vessels are certificated by the Coast Guard. Depending on their size these vessels have required crews of one ocean operator as compared to those in 24 hours service that required 2 ocean operators and crews of as many as four persons. Almost all offshore vessels ranging in size from 45 feet to 120 feet are aluminum hulled.

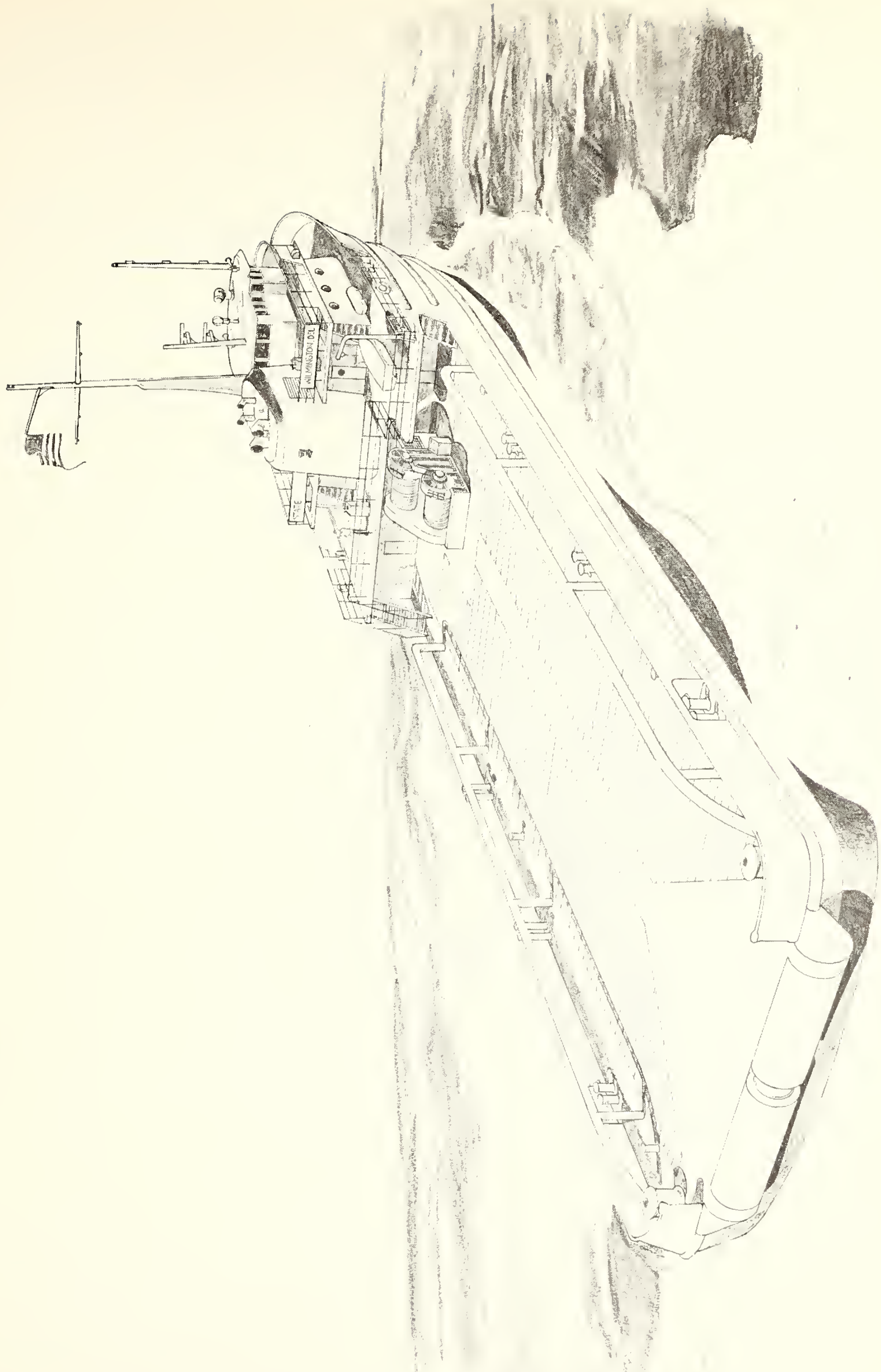


Figure I-12

In addition to the passenger carrying capabilities, all offshore vessels carry deck cargo in amounts ranging again on size from 10 tons to as much as 80 tons. These cargoes consist of general stores and equipment required of offshore drilling and development.

CHAPTER II

GENERAL DESCRIPTION OF THE MARINE ENVIRONMENT

Oil and gas exploratory drilling units and support vessels built under the MarAd Title XI program will generally operate in the Outer Continental Shelf of the United States; however, they could operate in any offshore area in any ocean of the world. For this reason, the marine environment is described here in only a general way.

For convenience, the marine environment may be grouped into two major categories: the coastal ocean and the open ocean. The coastal ocean includes estuaries and adjacent wetlands, lagoons, waters over the continental shelves, and marginal seas. The open ocean lies seaward of the continental shelf and is not significantly affected by continental boundaries or the ocean bottom.

Obviously, there is no clear-cut boundary between the coastal and open oceans; but for this statement, water deeper than 3,000 feet is considered to belong solely to the open ocean realm. Consideration of ocean conditions is necessary in order to make predictions of the movements and eventual fate of pollutants that may be spilled as a result of OCS exploratory oil and gas operations and for considering other environmental impacts arising from the support and servicing of such operations.

A. OPEN OCEAN[1,2]

Beyond the continental shelves, the open ocean is relatively unaffected by the continental boundaries. Over most of the open ocean, warm surface waters are separated from the cooler deep waters by what is known as the pycnocline, a rapid increase in density that more or less separates surface ocean waters from deeper waters. The deeper waters are known to move sluggishly after forming in the polar regions (primarily the Antarctic) and to return to the surface about 600 to 1,000 years later.

Away from the continents that interrupt surface water movements, ocean currents are primarily directed east-west. Only in the areas of the continental boundaries are the currents deflected to the north or south forming major boundary currents. Open ocean currents generally move surface waters at speeds of a few miles per day. In the boundary currents such as the Gulf Stream or the Kuroshio Current, the waters move at speeds of ten to a hundred miles per day.

Winds blowing across the ocean set the surface waters in motion. In the open ocean where tidal currents are relatively weak, these wind drift currents account for about 40 percent of the surface currents.

B. COASTAL OCEAN[1,2]

The coastal ocean is the water adjacent to the shore; there the adjacent land boundary, freshwater runoff from the land, and local atmospheric conditions contribute significantly to the movement and mixing of the waters. The width of the coastal ocean varies, and its outer boundary is not well defined. It may be quite narrow along coasts where the continental shelf is narrow and where oceanic conditions and "permanent" currents come close to shore. Conversely, where the continental shelf is wide, the coastal ocean may be tens or even hundreds of miles wide. The coastal ocean does not, however, always coincide with the continental shelf. Where the shelf is very narrow, the coastal ocean may extend beyond the edge of the shelf, or where the shelf is very wide, the coastal ocean may extend out from shore for only a part of the shelf width.

Although making up only about 12.5 percent of the ocean surface, coastal ocean waters are vitally important. Heavily used for waterborne commerce, coastal waters are also used for recreational fishing and boating, commercial fishing, and waste disposal. Despite these heavy and often conflicting uses, coastal waters are still the most productive part of the world ocean; an estimated 90 percent of the world's marine food resources are harvested there.

There is considerable variation in the movement of the waters near the shore. Tidal currents are often strong, generally strongest near the shore. They generally parallel the coast and may be either oscillatory or rotary in character depending on local geography.

Inshore from the point where surface waves break, a longshore current paralleling the shoreline usually develops. The current direction depends upon the angle at which waves approach the shore. For example, along a coastline oriented in a north-south direction with the ocean to the east, waves approaching the shoreline from the north east will produce a longshore current that flows southward. Longshore currents are highly variable because of their dependence on local waves.

Outside the surf zone, the local winds and salinity gradients, caused by runoff from the land, combine to dominate nontidal currents in the near-shore areas. Since waves breaking on a shoreline at any given time may have been for the most part generated by storm systems some distance away, the direction of wave-generated currents nearest the beach may be opposite to the direction of the currents seaward of the surf zone.

Along coasts having relatively large freshwater inflows to the ocean, such as the Atlantic Coast of the U.S., the salinity and generally the density of surface water increases with distance offshore. The average net (nontidal) flow in the near-shore zone will, along such coasts in the northern hemisphere, be directed such that the shore is on the right of an observer looking down current. Such longshore currents are particularly well developed along coasts lying to the right (looking seaward) of the mouths of major estuaries -- south of the entrance to the Chesapeake Bay, for example.

At any particular time, however, currents in the coastal ocean may be dominated by local winds or by density-induced effects resulting from these winds. Hence, offshore winds will transport surface waters offshore, particularly if the wind is blowing at an angle to the shoreline such that an observer with his back to the wind has the shore to his left. Under these conditions warmer surface waters are transported offshore and cooler subsurface waters from offshore are brought to the surface near the shore, a process known as upwelling. The resulting density distribution produces, in the northern hemisphere, a current flowing along the coastline with the shore to the left of the current (looking down current).

When such an offshore or longshore wind ceases, the warmer surface layers move shoreward. In the presence of an onshore wind, the wind-induced currents run parallel to the shore in a zone just outside the breakers.

We know little of the process by which near-shore waters are renewed or mixed with open ocean waters. Where the runoff of fresh water from the land into the coastal ocean is sufficient to produce measurable salinity gradients, and where the rates of freshwater inflow can be determined, the mean residence time (or replacement time) for near-shore waters can be estimated. Such an estimate was made for the waters of the coastal ocean bordering the U.S. between Cape Hatteras and Cape Cod. Considering the salinity of the waters in this segment of the coastal ocean and the annual volume rate of flow from all rivers discharging from the adjacent coast, one obtains a mean residence time of about 1.5 years. Typical residence time range from a few months for a small estuary to several years for coastal ocean sectors.

C. ESTUARIES[1,2]

Most of the world's existing ports and harbors are located on estuaries. Despite their variety of shapes and sizes, estuaries commonly exhibit similar physical and biological processes. An estuary is a semi-enclosed coastal body of water that has a free connection with the open sea. Within

an estuary, seawater is measurably diluted with fresh water which runs off from the land. Four types of estuaries can be distinguished: drowned river valleys, bar-built estuaries, fjord-like estuaries, and estuaries produced by tectonic processes.

Drowned river valleys are perhaps the most familiar. They occur along the U.S. Gulf and Atlantic Coasts. Because they are generally confined to coastlines with relatively wide coastal plains, these waterways have also been called coastal-plain estuaries. These estuaries are widespread throughout the world and are commonly the sites of major ports. Philadelphia on Upper Delaware Bay and London on the Thames River are two examples of such estuaries.

The basic circulation pattern for estuarine waters is as follows:

> In a typical estuary, the salinity of the water increases with depth and distance from the shoreline; in other words, the freshest waters occur near river mouths with the saltiest water occurring near the sea. There is usually a surface layer in which the vertical salinity change is small, an intermediate layer in which salinity increases rapidly with depth, and a deep layer in which the rate of salinity increase with depth is small, as in the surface layer. Vertical mixing takes place between the surface and bottom waters.
>
> Tidal currents, ebb tides, and floods usually dominate in estuaries. Superimposed on the tidal currents (usually oscillatory in nature) is a net circulation pattern (called the estuarine circulation) in which there is a net seaward flow of near-surface waters and a net flow from the mouth toward the head of the estuary in subsurface waters. There is also a small net flow from the deeper layers to the surface layers. The volume of water flowing toward the head of the estuary (per unit time) decreases from the mouth to the head of the estuary, since water is simultaneously being moved upwards (entrained) from the deeper layers to the surface layers. Consequently, the amount of seaward flow of surface waters increases from the land toward the mouth of the estuary.

The basic estuarine circulation pattern prevails in most of the coastal ocean where the input of freshwater from river run-off and rain exceeds the loss by evaporation from the surface. Thus, over the continental shelf, surface waters generally have a net motion seaward, while near bottom waters move generally toward the shore as well as moving along the coast.

The extensive mixing of surface and subsurface waters, combined with the estuarine circulation, supply nutrients (phosphates and nitrates) to surface waters. With a plentiful nutrient supply and abundant sunlight, the phytoplankton (minute floating plants) of coastal waters produce the food to support abundant marine life, both fin fish and shell fish. Eggs and larvae of various organisms are also abundant. In the open ocean where there is less mixing, surface waters are depleted of nutrients and annual productivity of phytoplankton is much less than in coastal waters.

In coastal areas, winds from certain directions move surface waters seaward. With the abundance of nutrients, the productivity of phytoplankton is generally high. Upwelling areas support some of the world's richest fisheries. One small area offshore from Peru and Chile normally supplies about one-fifth of the World's annual fish catch. Another example of an upwelling area occurs in potential offshore drilling areas off California where an important northern anchovy fishery exists.

D. SHORES AND BEACHES[2]

The shore is a narrow strip of land bordering the ocean that is alternately exposed or covered by waves or by the changes in water level due to the tide. Where wave action is relatively vigorous and the supply of sand (or gravel) is adequate, the shore is marked by a beach, i.e., a movable deposit of loose sand (or gravel). In more protected areas, wetlands (either marshes or swamps) border the shoreline. In those areas where the land is rising due to mountain building (tectonism) or the recent retreat of continental glaciers, the shore may be marked by a rocky coastline such as the New England Coast (north of Cape Cod) or parts of the Pacific Coast of the U.S. and the shores of Puget Sound.

Rocky shores are typical of steeply sloping coastal land areas where the sea acts directly on resistant rocks. In many of the areas used for deepwater ports (especially fjord-like estuaries), rocky shorelines are common owing to the effects of glaciers that provided deep waters near shore needed for deep draft vessels. In such areas, marine organisms typically attach themselves to the rocks which support extensive communities of animals and plants.

Where sands and gravels are abundant, beaches form under the action of the waves. Built of loose sand or gravel, beaches build outward and retreat in response to changing wave conditions. Because beaches are of unstable substrate and contain little food, relatively few marine organisms grow in or on beaches. But they are not wholly devoid of life. On the lower parts of beaches where wave action is less vigorous, burrowing animals and Loggerhead Turtle rookeries may be found. In some areas, beaches are used by fish during their spawning activities. Nearby subtidal areas may also serve as nursery areas for juvenile fish.

E. WETLANDS[2]

Tidal channels and low lying areas around lagoons, estuaries, and behind barrier islands are covered either permanently or intermittently by seawater. These areas, known as wetlands, are most common along the Gulf and Atlantic coasts of the U.S. but also occur on the Pacific and Alaskan coasts. Because of the shallow water in the associated lagoons, sounds, and the water-logged soils of the regularly or intermittently flooded portions, wetlands have distinctive types of vegetation.

Wetlands are extensively used by wildlife such as waterfowl and aquatic mammals such as muskrats. Plants growing in wetlands are highly productive and constitute important food sources for marine organisms. The vegetated shallow water areas provide protection and act as hatching or nursery areas for many species of marine organisms important for commercial or recreational fisheries.

The shallow, warmer waters (usually less than 3 feet deep) in and around wetlands commonly support extensive growths of ellgrass (Zostrea) or turtlegrass (Thalassia). Regularly flooded intertidal salt marshes are generally covered by salt-tolerant grasses. On the Atlantic and Gulf coasts the marshes are covered by saltmarsh cordgrass (Spartina) and on the Pacific coast by bulrushes (Scirpus), glasswort (Salicornia) and arrowgrass (Triglochin). In southern and eastern Florida and Puerto Rico, the wetlands are regularly flooded by the tides and are covered with low trees, red mangrove, and some black mangrove.

Animals are important constituents of marshes. Fiddler crabs and snails typically live in the higher parts of the marsh. Mussels are abundant in the lower marsh, and oysters form extensive banks along tidal creeks. Commercially important furbearing animals inhabit coastal marshes along many coasts. In Louisiana marshes, for example, trappers take nutria, muskrat, mink, racoon, and other furbearing animals. Waterfowl, manatees, and other marine mammals inhabit wetlands. Rare and endangered species are often found here as well.

F. GEOLOGICAL FRAMEWORK OF THE CONTINENTAL SHELF[3,4]

The continental shelf is defined physically as the zone extending from the line of permanent immersion around a continent to the depth where there is a marked or rather deep descent toward the great depths. In 1970, the Hague Conference defined the continental shelf as:

> "...the area between the mean low water line and the change in the inclination of the ocean floor, from about one-eighth of one degree to more than three

degrees, that marks the beginning of the continental slope. This occurs at various depths, usually between 130 and 200 meters; but it can occur as shallow as 50 meters and as deep as 500 meters. The continental shelf ranges in width from zero to 1500 kilometers."

Geographically, the continental shelf is a subpart of the continental margin, a zone separating the submerged part of a continent from the deep-sea bottom. The other subparts are the continental slope and the continental rise.

The continental slope is the declivity from the outer edge of the continental shelf into the great depths. There exists a great variation in the steepness of the continental slope. For example, the slope off the northwest coast of Australia is less than 1^{o} whereas that off Australia's southwest coast is 27^{o}. The depth of the continental slope varies from 1400 to 3200 meters. The base of the slope is marked by the continental rise. The rise is a gently sloping and smooth surface formed by the joining of a number of deep-sea fans.

Continental shelves can be classified into two primary types of composition - those that are underlain by sedimentary strata and those underlain by igneous and metamorphic rocks. Generally, (with the exception of the area north of the Santa Barbara Channel), the continental shelves are the top surfaces of long, thick prisms of sediment and sedimentary strata which are held in position by fault blocks, diapers, and reefs which act as dams. Tectonic activity that was parallel to the base of the continental slope has formed tectonic dams. Under such circumstances, crystalline rock is uplifted parallel to the continent resulting in a basin between the uplifted rock and the shore. Sediment is deposited in this basin; the uplifted crystalline rock acts as a dam to trap the sediment which, after filling the basin, will spill over resulting in the formation of a slope. The Atlantic and Pacific coasts of the U.S. are examples of such activity. Other tectonic dams include those formed by diaper structures which have resulted from the upward movement of salt from a depth of many kilometers. Salt domes are common in the western Gulf of Mexico and are the principle tectonic dams in that area. Biogenic dams are the principle agent in the eastern Gulf of Mexico and off the southeastern coast of the United States. These dams are coral reefs, many of which are still living.

Shelf areas underlain by igneous and metamorphic rocks are found on top of tectonic dams. Many of these shelves had a sediment cover that was stripped by glaciation. An example is the continental shelf off Maine where glacial erosion has removed the sedimentary rocks that once covered such dams. Most of the other continental shelves that are known to be underlain by igneous and metamorphic rocks are at higher latitudes where glacial erosion has been an effective agent.

A very important event in the evolution of the continental shelves occurred during Pleistocene glaciation when the sea level changed as a result of water being locked up in glacial ice. The sea level was lowered by as much as 150 meters, and a great amount of erosion took place on the sediments of the continental shelves that existed at that time. As a result, about 70 percent of the world's continental shelf-area sediments have been laid down in the past 15,000 years since the last significant glacial lowering of the sea.

There are several geomorphic features that occur on the continental shelves and slopes which are significant. Some of the more important features include drowned valleys, tidal channels, drowned glacial troughs, submarine canyons, fan-valleys or channels, delta-front troughs, slope or sea gullies, submarine grabens or rifts, reefs, salt domes, and submarine mounds.

G. GEOLOGY OF OIL AND GAS ACCUMULATION

Oil and natural gas are hydrocarbons, as are coal, shale oil, and tar sands. Natural gas is primarily methane, the simplest of the hydrocarbon compounds which range from natural gasolines to very viscous crude oils. Intermediate between natural gas and crude oil are natural gas liquids which are mixtures of propane and heavier compounds. They are extracted during the production of natural gas.

Large accumulations of oil and natural gas owe their existence to the interplay of three essential geologic elements. These are: (1) source beds -- rock strata, e.g., marine shales, marls, and limestones, which supply the organic material that is eventually transformed into fluid hydrocarbons; (2) reservoir beds -- porous strata, e.g., sandstone or limestone, into which hydrocarbons migrate; and (3) a trapping mechanism -- a structural or stratigraphic barrier which interrupts further migration and allows significant hydrocarbon accumulations to develop.

Oil and natural gas result from the slow chemical change of biological material (dead marine animal and plant debris) that was deposited in thick layers of sediments during the last 600 million years on what was then the earth's surface. These chemical processes occur at extremely slow rates and require initial conditions of quick burial such as those found in areas of rapid sedimentation. After oil and natural gas compounds formed in an oxygen-deficient environment, they migrated upward through the water-saturated sedimentary rocks (the hydrocarbons having a lower density than water) and eventually, either escaped into the atmosphere or were trapped by a layer of impermeable rock. Resulting oil and gas accumulations are density-stratified; gas, if present as a separate phase, assumes the highest position in the trap while any water present, being more dense than both oil and gas, assumes the lowest. All these liquids exist under relatively high formation pressures due to the weight of overlying rock strata.

H. BIOLOGICAL FRAMEWORK OF THE CONTINENTAL SHELF[4,5]

The offshore environment is broadly divided into the pelagic and benthic realms. The pelagic realm includes all ocean water above the bottom. Over the continental shelf, the waters constitute the meritic province. Waters over the slope and deep ocean bottom constitute the oceanic province. The biota of the pelagic division is generally subdivided into plankton and nekton. The benthic division includes the sea bottom and sub-bottom environment, and its biota is called benthos. Meroplankton refers to marine species which have planktonic stages during their life but are not planktonic in their adult forms. Holoplankton refers to those species which are planktonic throughout their life cycle.

1. Pelagic Realm - Plankton

All motile aquatic organisms, plant or animal, whose powers of locomotion are too feeble to resist the set and drift of currents are termed plankton. The plankton is divided into several different types on the basis of physiology and life history.

Phytoplankton includes the acellular (unicellular) floating plants and all floating multi-cellular plants such as Sargassum. As plants, all phytoplankters are capable of producing their own food from raw materials by photosynthesis. The ubiquitous distrubution and occurrence in pelagic waters is influenced by several factors. Both the horizontal and vertical distributions of phytoplankton are dependent on: (1) population origin and life cycles, (2) supply and level of nutrients and growth factors, (3) physiological requirements and adaptability, (4) salinity and temperature, and (5) grazing pressure by heribivores (plant-eating animals). In addition, vertical distribution alone is influenced by: (1) vertical water mixing, diffusion, and water stability, and (2) depth of the lighted zone.

The animal plankters are called zooplankton. Zooplankton distributions and occurrences are also relatively continuous in pelagic waters. In general, they are influenced by the same factors that affect phytoplankton distribution and occurrence. Inorganic nutrients and depth of the lighted zone are not as immediately important to zooplankton as to phytoplankton, but these factors affect distribution and abundance in that greater availability of nutrients and light allow higher primary productivity and consequently a greater food supply for zooplankton.

2. Pelagic Realm - Nekton

Organisms which remain suspended in water and whose powers of locomotion are great enough to resist the set and drift of currents, being subject only to large-scale physical forces,

are called nekton. Nekton for the offshore waters are represented by five major taxonomic categories - marine mammals (whales, dolphins, porpoises, seals, otters, manatees, etc.), marine reptiles, the fishes, the cephalopod mulluscs (octopus and squid), and certain crustoceans (shrimp and swimming crabs). Individuals of this group commonly, but not always, range over broad areas, thus participating in several biotic communities. For example, shrimps have a pelagic planktonic larvae, an estuarine juvenile, and a pelagic adult. However, most nekton are limited in geographic and vertical ranges by the same environmental conditions as less mobile organisms, i.e., temperature, salinity, available food, and types of bottom.

The nektonic component of the environment can be divided into strictly open water nekton and nekton which spend some portion of their lives in nearshore, estuarine, or marsh waters, examples of the latter are shrimp, drum, croaker, menhaden, flounder, seatrout, salmon, etc. Many finfish of commercial and sportfishing importance, however, are strictly open water residents, such as red snapper, various groupers, sailfish, and marlin.

Many organisms are demersal; i.e., they have a particular habit of living on, or just above the sea bottom. Since distribution and abundance of demersal organisms is generally regulated by sediment type and the bottom communities that supply food, these organisms can be considered to be part of the benthos.

Marine birds feed on fish, plankton, and detritus. Fish-eating birds return nutrients from the sea back to shore and are instrumental in recycling nutrients. Feces contain more readily usuable forms of nutrients than the food organisms. Sea birds also utilize the shoreline, i.e., beaches, marshes, cliffs, etc., for breeding and raising their young.

3. Benthic Realm - Benthos

Organisms (plant or animal) which, as adults or in sessile stages of their life cycles, live on the bottom are called benthos. The benthos is characterized by the large numbers of sessile or relatively inactive animals which exhibit marked zonation in the inshore region. The organisms are generally distinct for each of the three zones of the neritic province (supratidal or suppralittoral, intertidal or littoral, and subtidal or sublittoral). Zonation is characterized more by dominant species than by distinct assemblages of numerous species.

The benthic environment is in general affected and defined by the same factors that influence the waters above the bottom. Additional factors to consider for the sea bottom alone are: (1) nature of the substrate, (2) nature of the sediment, and (3) sub-bottom temperatures, salinity, oxygen, and pH. The substrate may be hard or soft depending on the amount and nature of sedimentation and the degree of scouring by horizontal currents. Sediment type is usually described by percentages of carbonates, evaporites, sand, silt, and clay. Sub-bottom temperature, salinity, oxygen, and pH can be much different than the overlying waters, especially oxygen and pH values. The benthic environment becomes more stable at greater depths, i.e., it is less affected by physical forces such as currents, waves, and storm surges. Temperature and salinity data tend to fluctuate less and have smaller ranges of values than in shallow water areas closer to the air-sea interface.

The major subdivisions of the biota found in the benthic environment are epiflora, epifauna, infauna, and inflora. Epiflora are plants, cellular or acellular, macroscopic or microscopic, which are attached to or living on the bottom. Inflora are plants found in the interstitial spaces of the bottom substrate. The main benthic floral groups are the seagrasses and the benthic algae. The benthic algae predominantly inhabit rocky coastlines and hard bottom. The scarcity of such habitats allows seagrasses to dominate.

Benthic fauna which live on the bottom are termed epifauna. Many species are permanently attached to the bottom, a life style not found in the terrestial environment. Many of the epifauna are colonial or consist of groups of individuals incompletely separated from one another. These organisms have developed life-forms which appear more like conventional plants than animals. Other epifauna creep about on the bottom, and some are highly motile. Epifaunal range from the sessile organisms like sponges and anemones to the slower moving forms such as shrimp, lobsters, and crabs to the highly motile demersal fish such as flounder, red snapper, salmon, croaker and grouper.

Infaunal organisms, animals which live buried in unconsolidated sediments or burrows in solid substrates, play a major role in reworking the sediment. Fixed infauna are those which live in permanent burrows; burrowing infauna move about, displacing sediment as they go on by creeping or swimming between the sand grains. If they progress by displacing sediment particles, they are called megafauna (echinoderms, mulluscs, flatworms, and annelids).

I. NATURAL PHENOMENA AND OCS DEVELOPMENT[5,6]

The environments of OCS areas are at times subject to the stress of a variety of natural phenomena, such as earthquakes, tsunamis, severe storms and ice. These phenomena can impact oil and gas operations on the OCS.

Earthquakes represent the major geologic hazard, resulting in ground cracking and possible landslides. The danger of earthquakes occurring varies with different OCS areas. For example, the Gulf of Alaska is subject to frequent and severe earthquakes. Alaska and the Aleutian Islands are part of the great seismic belt that circumscribes the Pacific Ocean. Since 1917, the Gulf of Alaska has experienced eight earthquakes above 7.0 on the Richter scale. The 1964 Alaskan earthquake (Prince William Sound) was estimated at between 8.3 and 8.6 Richter. Significant damage extended over 100 miles from the epicenter and permanent ground deformations occurred over 100,000 square miles. At one point, the Gulf floor rose vertically about 30 feet and moved horizontally about 80 feet. On the other hand, the risk of earthquakes in the Gulf of Mexico is only slight. Seismic risk for the western Gulf of Mexico is zero. No earthquakes of any notable intensity have been recorded for this area, and only two earthquakes of notable intensity have occurred in the Gulf near this area, neither of which produced damaging tsunamis nor were they considered well located events. In areas of the eastern Gulf of Mexico, there is some danger of earthquakes of low intensity.

Tsunamis - seismic sea waves (more commonly referred to as "tidal waves") are long-period, high-intensity ocean waves generated by large-scale, short-duration movement of the sea floor. Nearly all tsunamis are associated with large submarine earthquakes of Richter magnitude 6.5 or greater. Tsunamis are characterized by great speeds of propagation (up to 600 miles per hour), long periods (varying from a few minutes to a few hours, but generally 10 to 60 minutes), and low observable amplitudes in the open sea. Upon entering shallow water along an exposed coast, often thousands of miles from the source, a tsunami may reach a height of 100 feet and cause considerable damage and loss of life. Tsunamis are generated locally or can result from remote disturbances. The impact of a single occurrence may be felt thousands of miles away. For example, the 1960 tsunami which began in Chile and killed hundreds there, reached Japan 24 hours later, killing 200 persons and destroying 5,000 structures and 75,000 boats. An earthquake of 7 Richter - the largest recorded in the Atlantic - would probably generate a seismic sea wave no more than 6 feet high. On the other hand, an earthquake of 8 Richter could cause 30-foot waves and significant damage.

Recurrent severe weather is as important to daily OCS operations as maximum wind speed and wave heights are to structure design. Severe weather affects exploratory drilling more than any other phase of operation. Waves can move a mobile platform enough to increase dynamic stresses on equipment handling devices and to cause seasickness. In the North Sea, drilling operations have been shut down for weeks at a time, especially during winter periods. In the last five years, semisubmersible drilling operations have experienced a 20 to 30 percent downtime attributable to severe weather from October through March. The annual average downtime in the North Sea has been about 15 percent. Severe weather does not pose as great a problem during production, especially if pipelines are used to transport the product to shore. If a single-point mooring is used, inability to moor the tanker during stormy weather can cause shutdowns. Hurricanes and cyclones pose the most severe storm threat to OCS operations. By way of example, the Middle and South Atlantic OCS areas are subjected to more extreme severe storm conditions due to hurricanes than either the oft times stormy Gulf of Alaska and North Sea. Storms with sustained winds of at least 100 knots can be expected to occur at least once over a 90-year period in the North Sea, whereas in the Gulf of Alaska the period would be 50 years, and in the Middle Atlantic it would be 30 years. Further, significant wave heights of 55 feet can be expected to occur at least once during a 100-year period in the Gulf of Alaska, a 60-year period in the North Sea, and a 25-year period in the Atlantic.

Ice can cause or contribute to environmental impacts in northern OCS waters, e.g., north of the Aleutian Islands. Ice can form on fixed structures and ships' superstructures, thus increasing the structural stresses. Ice also presents a potential hazard to fixed structures due to collisions of ice propelled by tidal currents and when icebergs occur in navigation routes. Pack ice in northern waters can pose a hazard to fixed structures. Ice in motion has tremendous force. When it encounters the coastline, ice blocks are thrust up on the beach, scouring and gouging the beach and adjacent sea bottom. The action has been reported to occur in depths of 90 to 150 feet on the outer continental shelf. Scour widths of 100 to 200 feet, lengths of 2 to 3 miles, and scour relief of 30 feet have also been noted.

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CHAPTER III

ENVIRONMENTAL IMPACT OF VESSELS ENGAGED IN OFFSHORE OIL AND GAS DRILLING OPERATIONS

Development of offshore oil and gas resources involves a number of steps: (1) geophysical exploration, (2) exploratory drilling, (3) field development, (4) production, (5) transportation and storage, and (6) processing. The primary environmental impacts addressed by this statement are those resulting from offshore oil and gas exploratory drilling operations and the related servicing and support activities. The Maritime Administration Title XI program covers vessels engaged in such activities. Secondary impacts related to the Program include those due to offshore oil and gas field development, production, transportation, and storage and to shipyard construction and repair activities.

The continental shelf of the U.S. measures 875,000 square miles (560 million acres). Of this, about 2 million acres are under lease, leaving tremendous expanses of unleased and untested shelf areas. In other areas of the world, there are offshore oil and gas reserves that are being developed. The major offshore areas are the Persian Gulf, Venezuela, and the Gulf of Mexico. Other offshore areas containing significant oil and gas reserves are Australia's Bass Strait; the northwest coast of the island of Borneo; the west central African coast; the Gulf of Suez; and offshore Indonesia, Iran, Libya, Norway, Great Britain, Peru, and the USSR.[1]

The development and production activity on the continental margin areas will result in a variety of impacts on the natural environment, on other resource uses, on air and water quality, on land use patterns, on the social order and on economics. Some harmful impacts are the unavoidable result of routine operations while others are caused by occasional human error. Still other impacts are avoidable and can be controlled or avoided by safe operating procedures and by strictly enforced regulations.

A. DEVELOPMENT OF OCS OIL AND GAS RESOURCES

1. EXPLORATORY DRILLING (2)

Geophysical exploration describes all the techniques, except drilling, used to locate geological formations which may potentially contain oil and gas accumulations. It includes passive reconnaissance techniques such as air and shipborne measurements of the earth's magnetic and gravity fields and of hydrocarbon seeps into the atmosphere as well as active surveying techniques such as seismic analysis, bottom sampling, and bottom coring.

After a geophysical survey has located geological formations which possibly contain oil and gas, exploratory drilling is required to determine whether commercial quantities are present. The drilling equipment is mounted on a platform as described in Chapter I, e.g., a barge, a drill ship, a semisubmersible, or a jackup. The drilling unit is positioned over the site, and the exploratory drilling operation begins by rotating a drill bit on the bottom of a string of pipe. See Figure IIIA-1. Cuttings from the drill face are removed by a fluid called "drilling mud" which is pumped down through the pipe, out through the bit and circulated back to the surface via the annular space between the drill string and the bore hole. At the surface a pipe carries the cuttings in suspension to the drilling unit where the cuttings are removed and the drilling mud is re-used. Sporadically, depending on water depth, when a soft formation is suddenly encountered, it might be required to release the mud column in the riser, whole or in part, by opening a dump valve at the ocean floor.

The most serious hazard during exploratory drilling stems from the possibility of a blowout - the sudden surge of oil or gas pressure up the drill hole causing loss of control over the well. Although most blowouts involve only gas, large quantities of oil may be released to pollute the marine environment. If ignited, oil and gas may burn out of control, threatening personnel and equipment.

Drilling companies employ safeguards to minimize the likelihood of blowouts. The heavy "drilling mud" fluid is circulated in the drill hole to counteract the possible sudden flow of oil or gas. Other safeguards used include encasing the upper part of the drill hole with steel pipes set in concrete to minimize the possibility of a blowout around the outside of the drill pipe and installing blowout preventers -- control valves capable of closing off the bore hole in case a blowout does begin.

The type of casing used depends on the geological structure and the formation pressures encountered in drilling. A cross section of a typical geological structure and the casing configuration required for safe operation is presented in Figure IIIA-2.

The casing provides an anchor to which the blowout preventer (BOP) stack is attached. The BOP stack is a series of control valves which can close part or all of the drill hole if there is a threat of losing control of the well. See Figure IIIA-3. Pipe rams close off the annular space between the casing and the drill pipe if oil or gas blows the drilling mud up the annulus. Blind rams close the entire drill hole when there is no drill pipe in the hole. Shear rams close the holes by shearing the drill pipe and dropping it into the well.

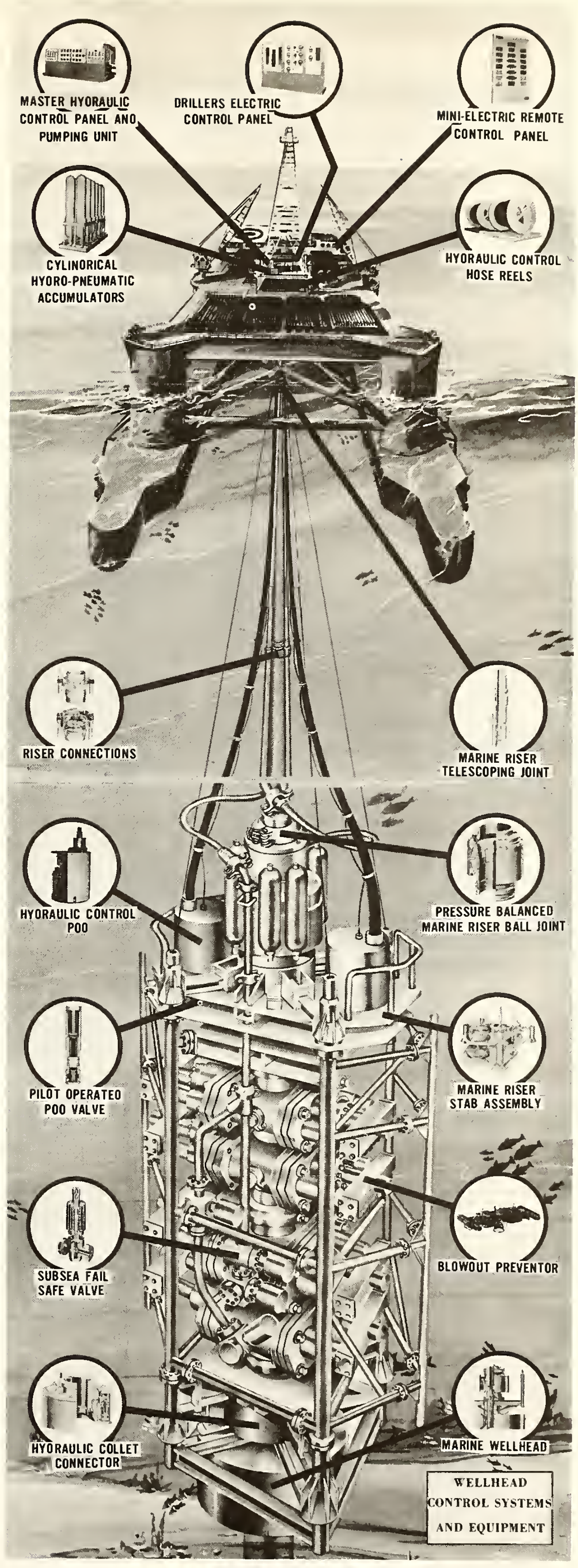
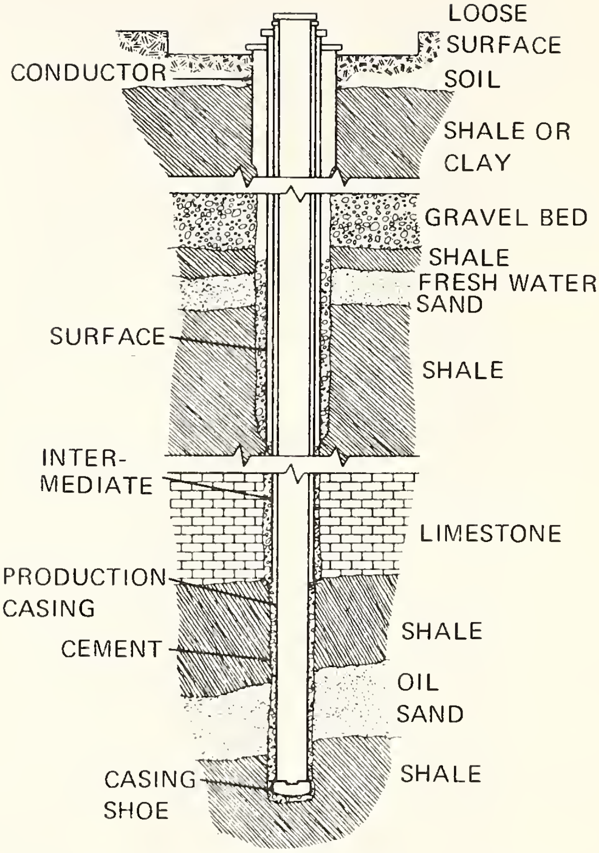
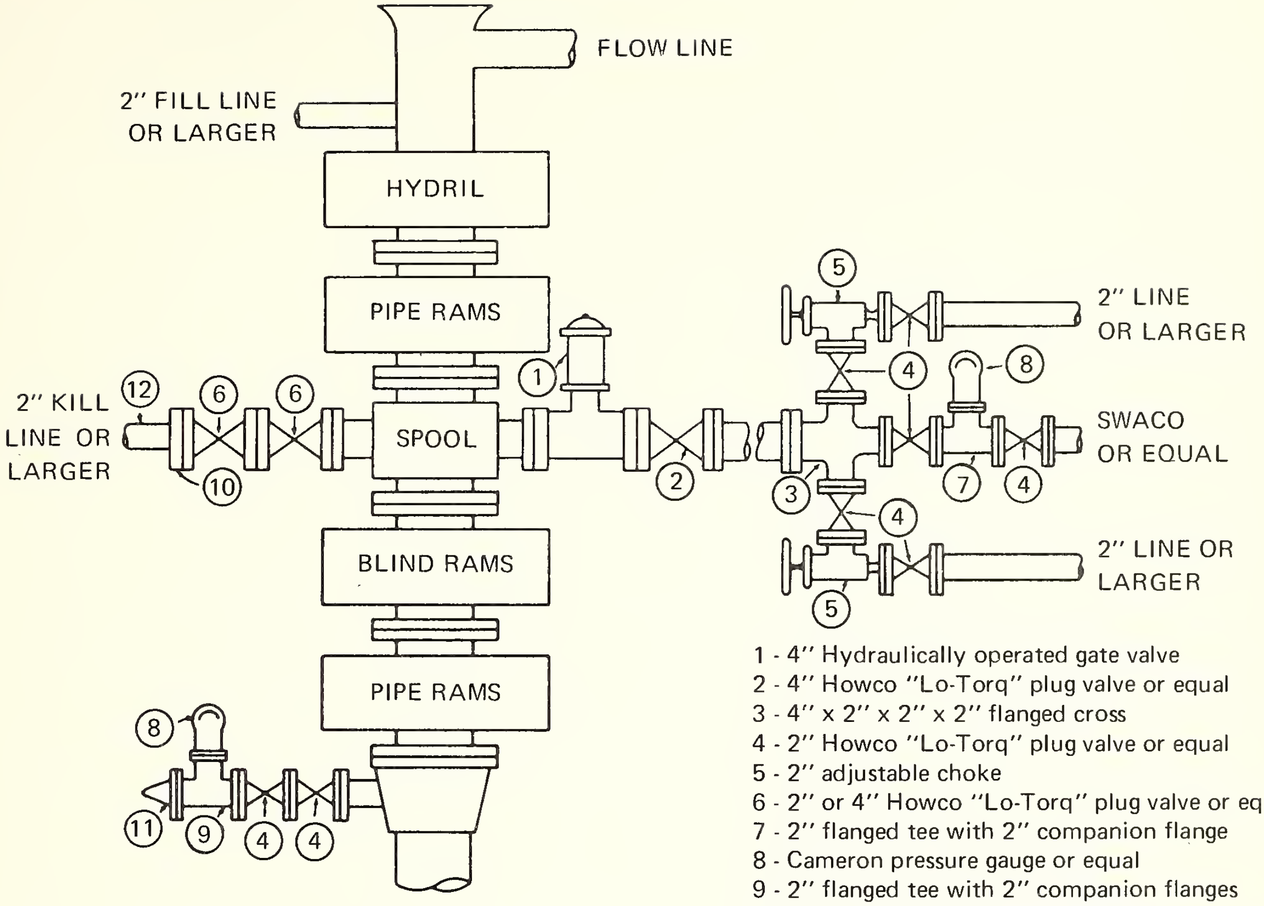


FIGURE IIIA-1



Source: Petroleum Extension Service, Division of Extension, University of Texas, *A Primer of Oil Well Drilling* (3d ed., Austin: Petroleum Extension Service, University of Texas, 1970).

Figure IIIA-2 Geological Structure and Casing in a Typical Oil Well



1 - 4" Hydraulically operated gate valve
2 - 4" Howco "Lo-Torq" plug valve or equal
3 - 4" x 2" x 2" x 2" flanged cross
4 - 2" Howco "Lo-Torq" plug valve or equal
5 - 2" adjustable choke
6 - 2" or 4" Howco "Lo-Torq" plug valve or equal
7 - 2" flanged tee with 2" companion flange
8 - Cameron pressure gauge or equal
9 - 2" flanged tee with 2" companion flanges
10 - 4" x 2" adapter flanges (if needed)
11 - 2" tapped bull plug
12 - 2" or 4" flanged check valve (optional)

Source: Tetra Tech, Inc., 1973, "The Effect of Natural Phenomena on OCS Gas and Oil Development," prepared for the Council on Environmental Quality under contract No. EQ4AC010.

Figure IIIA-3 A Typical Blowout Preventer Arrangement

Blowouts sometimes occur regardless of the counter-balancing effect of the drilling mud, the casing, and the blowout preventer. When this does occur, certain response techniques and equipment are employed, depending on whether the well is being drilled or is producing and whether the escaping oil or gas is burning. If possible, the well is capped. When damage to the well head prevents capping or when serious environmental pollution will result if blowing oil is not consumed, the escaping gas and oil are allowed to burn at the surface and relief wells are drilled to the producing zone or zones. Mud, water, and/or cement are pumped down the relief well to close the formation and stop the blowout.[3]

2. FIELD DEVELOPMENT (2)

Discovery of commercial quantities of oil or gas calls for development plans which consider additional exploratory wells to determine the extent and capacity of the field; selection, construction, and assembly of the production facility; number of production wells; and transportation of the oil or gas to a processing plant. These development plans for OCS and state leases are submitted to the responsible Federal and state authorities, respectively, for approval before development begins.

a. Field Development Facilities

In contrast to exploratory drilling, most offshore development and production facilities are fixed platforms. A fixed platform may be used to drill 10 to 30 wells. After all wells are drilled, the drilling rig is disassembled, and production equipment is installed on the platform.

An emerging alternative to fixed production platforms is the subsea production system which involves placing the well heads on the ocean floor rather than on platforms. There are three types of subsea systems under development: single subsea wells, encapsulated systems, and nonencapsulated multiwell systems.

The single subsea well is drilled from a mobile rig and is then completed on the ocean floor. Oil and gas are piped to a nearby fixed platform or to a shore facility. Eighty-two of these systems are now active. For the second type, dry chambers enclose essentially dry land well heads on the ocean floor. Workmen enter the 1-atmosphere (nominally 14.7 pound per square inch pressure) chamber from a diving bell or submarine. If 1-atmosphere encapsulated systems can be economically extended to 3,000 feet depths, the cost of subsea completions will be relatively insensitive to water depth. The third type involves a wet system of several clustered subsea wells drilled from a vessel positioned over the system. The production equipment is located within the system and is serviced by a diving bell (which does not require a professional diver).

b. Drilling and Well Completion

After the fixed platform or subsea system is assembled, development drilling, similar to exploratory drilling, commences. Generally, a number of wells are drilled from a single platform. Directional drilling -- a standard practice which directs the drill off a vertical line to reach lateral sections of the oil or gas reservoir -- makes the most economical use of the expensive platforms.

If commercial quantities of oil or gas are found, the well is completed, a term describing various steps in preparing a well for production. Completion can include setting and cementing casing, perforating (cutting holes in the casing which will permit oil or gas to flow from the formation into the well hole), fracturing (applying pressure or using explosives to increase formation permeability), acidizing (using acid to enlarge openings in the formation), consolidating sand (to keep sand from entering the well bore), setting tubing (conduit for routing the oil or gas to the surface), and installing downhole safety devices (valves installed to prevent blowouts during production). If performed after initial completion, they are considered servicing or workover operations.

Development drilling is generally less hazardous than exploratory drilling because the characteristics of the geological formations are better known. The potential threat of a blowout, however, remains.

The severity of a development well blowout increases significantly if oil or gas is being produced simultaneously from wells already completed.

If a dry well is drilled, it is plugged with cement and abandoned. If a well is to be abandoned, either because it is a dry well or all the economically recoverable resource has been extracted, then all casing and piling is severed to at least 15 feet below the ocean floor and is removed. In the past, stubs of casing and piling extending above the bottom have interfered with fishing and navigation. Current procedures for OCS well abandonment are covered in OCS Order No. 3.

3. PRODUCTION (2)

Once a well is completed and connected to production facilities, production may begin. If oil, gas and other materials are produced, they must be separated. The oil is separated, metered, and pumped to shore by pipeline, to offshore storage tanks for eventual transfer to a tanker, or directly to a tanker. The gas is separated; if it contains water, it is dehydrated by contacting it with glycol; and then it is pressurized, metered, and pumped to shore by pipeline. Where there is no gas pipeline or OCS gas production is not economical under prevailing market conditions, the gas is pressurized and reinjected into the reservoir.

When water is produced with the oil, separation is required. Consistent with OCS Order No. 8, separated water may be discharged into the ocean. The maximum allowable oil content is 100 parts per million; the average allowable oil content is 50 parts per million or less. Sand produced with the oil may be discarded into the ocean after the oil has been removed, as required in OCS Order No. 7. The Environmental Protection Agency has recently developed stringent effluent limitations and guidelines for the offshore segment of the oil and gas extraction point source category. These requirements are contained in a new Part 435 to Chapter 40 of the Code of Federal Regulations and will be applicable in the near future.

Because of the possible explosions and fire, storms, and earthquakes, many devices are installed to warn of impending or existing dangers and to control or stop the flow of gas and oil if trouble is sensed. Some of the safety devices with which fixed platform production facilities are equipped are pressure, level, and combustible gas sensors; manual, automatic and pressure relief valves; and fire detection and fighting equipment. In addition, each well is equipped with a subsurface safety valve which can shut the well down in case of surface equipment failure. Required safety and pollution control equipment and procedures are described in OCS Order No. 8.

Although production is a continuous activity, it is sometimes necessary to shut down and reenter a well to improve or restore production. A variety of operations may be involved in workover and servicing, including further drilling to deepen the well. Because the well may be active and/or open, well control is the primary safety consideration, requiring the use of blowout prevention equipment.

4. TRANSPORTATION (2)

Crude oil and natural gas liquids may be transported to onshore processing facilities by pipeline. All the natural gas now produced in the Gulf of Mexico and off Southern California is transported to shore by pipeline. All the oil produced off California and 97 to 98 percent of the Gulf oil is piped to shore. Because most of the OCS geological formations with oil and gas potential lie within 200 miles of shore, pipelines will probably continue as the preferred OCS transportation mode.

Tankers may well be used for transporting oil during the early phases of field development in areas remote from established producing fields. Production can begin earlier, particularly far offshore, if tankers are loaded from offshore moorings in or near the field.

a. Pipelines

Pipelines transport large volumes of oil and natural gas. Once the pipeline route is selected and the volume to be pumped is determined, pipe size and strength are selected, and line pressures calculated. Considered during route selection are bottom and subsurface foundations; current, wave, and tide conditions; and other uses -- shipping, commercial fishing, naval operations, etc. -- of the area to be crossed.

Primary techniques for laying pipe in coastal waters are section-by-section or "stove pipe", reel barge, and pipe pulling. In the stove pipe method, short sections of pipe are welded together on a pipelaying barge. While the barge moves slowly forward, the completed pipeline is released into the water and laid on the ocean floor. There are several types of barges and several ways to lower the pipe. The vessel may have a barge or ship hull or it may be semisubmersible. The barge hull is the most common, although it limits operations to relatively calm seas -- 6 to 14-foot waves. Semisubmersible hulls are the most stable. Behind the barge, the welded pipe section is supported by a pontoon or "stinger" that reduces stress caused by the pipe's own weight. The two most commonly used pontoons are the straight, rigid stinger and the curved stinger.

In the reel barge method, pipe is welded together onshore and is wound onto a large reel on the pipelaying barge. The pipe is laid as it unwinds. For pipe diameters in the 4 to 10-inch range, reel barges are often more economical than other types of barges. The technique is limited to pipe diameters of 12 inches or less.

Pipe pulling uses barges and tugs to pull sections of welded pipe from an onshore launchway over the pipeline route. This method is limited to pipeline of relatively small diameter and short length. Generally, it is used only for laying pipelines near shore.

In water depths of less than 200 feet, present OCS administrative procedures require burial of the pipelines. The minimum depth of burial is 3 feet except in shipping fairways and anchorage areas, where the minimum depth is 10 feet. Technology exists to bury pipelines in water depths of 600 feet, for cases where such action is deemed advisable. However, one of the most effective methods of protecting a pipeline from damage due to earthquakes, is to leave the portion in deeper waters on the ocean floor surface where it can maintain as much independent flexibility relative to the surface as possible.

Conventional dredging equipment can be used in shallow water, but it is practically impossible to lay a line in a previously prepared trench in deep water. For this reason marine pipelines are commonly buried after the line is laid.

Burial is usually affected by jetting sediment away from underneath the pipeline and allowing it to sink into the resulting trench. The equipment used in this operation consists of a work barge equipped with high volume/high pressure water pumps and air compressors. From the barge, a multiple-membered towline, consisting of a strength member, water line, and air line, extends downward to a U-shape structure which straddles the pipeline and glides along it on rollers. Affixed to the U-shaped jetting device are several nozzles which direct water and air, under high pressure, ahead and below the pipeline. Sediments are blasted out of the narrow trench by the water jets, partially lifted by the air and deflected to the sides by various types of fins. The suspended sediments fall diffusely along either side of the trench. As the jetting device is pulled forward, the pipeline settles into the trench and is partially buried quite soon by the reworked sediment as it slips and settles back into the depression. Complete burial and restoration of original bottom contours may require additional time. In shallow waters, experience has shown that contour restoration is quite rapid, whereas in deeper waters, more than a year may be required. The jet method is most effective in fairly soft formations, but the use of extremely high pressure, high velocity jets makes the system effective in most sea floor sediments.

b. Tankers and Barges

Although tankers and barges transport less than 3 percent of the oil produced in the Gulf of Mexico, tankers may be used in the initial phases of field development in OCS areas. Transportation of oil by tanker has recently received considerable attention because of the development of Very Large Crude Carriers (VLCC) or supertankers and because of subsequent proposals for siting superports off U.S. coasts. Because a supertanker is economically advantageous only over great distances -- from the Persian Gulf to the United States, Western Europe, or Japan, for example -- VLCCs will probably not be used in OCS operations.

Oil pollution from tankers and barges results from collisions and groundings and from operational problems such as equipment failure, human error, and operational discharges. The major source of oil pollution from tankers is intentional discharge -- the pumping of oily ballast water and tank washings into the oceans. Over 70 percent of all oil released from tankers has been due to these routine operations. Another important source of pollution from tankers is spillage as oil is being transferred to and from tankers at marine terminals. Mechanical failure, faulty design, and human error account for most of this spillage.

Single point moorings (SPM), also known as single buoy moorings (SBM), have recently been developed to reduce the hazards of storms to tankers and to minimize oil spills during loading. Over 100 SPMs are in use throughout the world. A tanker is moored to a single point, and loading hoses are connected between it and the buoy. Because the mooring and hoses can circle the buoy, the tanker moves to head into waves, tides, and storms. The SPM thus allows a tanker to remain moored in 15 to 20-foot waves accompanied by winds and currents.

5. OFFSHORE OIL STORAGE (2)

As development proceeds farther from shore, it may become economical to store the oil offshore temporarily while awaiting tankers. This is especially important when severe weather conditions prohibit the mooring of tankers for extended periods of time.

Three types of offshore oil storage systems are now being used in various parts of the world -- elevated, floating, and bottom standing.

The size of an elevated storage facility is severely limited because it must be mounted on a platform far enough above the water surface to avoid wave action during the most severe storms. The structural capability of the platform, then, is the limiting factor. In the Gulf of Mexico, maximum storage capacity on an individual platform is 10,000 barrels.

Several large floating storage barges are now in use. The one million barrel barge, PAZARGAD, is a storage, desalting, and loading facility in the Persian Gulf. It employs a single point moorint (SPM) system in order to head into the winds and currents and to withstand storms better. Another barge of the same volume, also moored to a SPM, is being used off Indonesia.

Storage facilities which rest on the ocean floor either may be submerged or may extend above the water surface. The most outstanding examples are the three dome-shaped tanks of the Dubai Petroleum Company in the Persian Gulf and the cylindrical concrete tank of the Phillips Group in the Ekofisk area of the North Sea. The Dubai tanks stand in 150 feet of water. Each has a capacity of 500,000 barrels. Oil is loaded into tankers from a SPM.

The Phillips tank, with a capacity of one million barrels, stands in 230 feet of water. Production equipment is mounted on top of the tank which extends nearly 100 feet above sea level. The side of the tank is protected from wave action by a perforated outer wall.

B. OCS ACCIDENTS, OIL SPILLS, AND CHRONIC DISCHARGES

Marine Pollution has been defined by the United Nations Conference on the Human Environment (June 1972) as the introduction by man, directly or indirectly, of substances or energy into the marine environment resulting in such deleterious effects as harm to living resources, hazards to human health, hinderance to marine activities including fishing, impairment of quality for use of sea water, and reduction of amenities. Impacts on the marine environment from vessels engaged in offshore drilling, support, and service operations come from drilling activities and from vessel casualties and operations. Vessel generated pollutants other than oil include sewage, garbage, stack exhaust, and noise. Other sources of marine pollution resulting from oil and gas development on the OCS are production, storage, and transportation activities.

It has been estimated that approximately 6.1 million metric tons of petroleum hydrocarbons (oil) -- or about 0.25 percent of that produced -- entered the ocean annually during the 1971-1972 time frame. Major petroleum sources were calculated to be: marine transport - 33 percent; river runoff - 27 percent; coastal activities - 18 percent; atmospheric fallout - 10 percent; and offshore petroleum production - 2 percent.[4,5]

From 1953 through 1972 -- when nearly all the wells were drilled in the U.S. OCS -- 43 major accidents occurred (see Table IIIB-1). Nineteen were associated with drilling, 15 with production, and 4 with pipelines. Over the 19 years, there has been an average rate of 0.005 (0.5 percent) drilling and production accidents per successful OCS well drilled. During the same period, 8 blowouts were recorded in state waters, i.e., within three miles of the coast.

The frequency of OCS accidents generally increased as activity increased until 1968 when the accident frequency peaked. It has been decreasing since then. The 1969 Santa Barbara blowout raised serious questions on the adequacy of OCS technology, and the State of California imposed a moritorium on all new drilling on existing state tidelands leases. On December 11, 1973, the California State Lands Commission lifted the moritorium. The three member commission unanimously adopted a staff report indicating that the oil industry had developed safety equipment and procedures that minimized the possibility of a major oil spill occurring and provided for effective clean-up in the event of a spill.

TABLE IIIB-1

Major Accidents on the U.S. Outer Continental Shelf, 1953-1972

Results	Drilling	Production	Pipeline	Collision	Weather	Total
Number	19	15	4	2	3	43
Oil	0	3	4	1	3	11
Oil and gas	2	7	0	0	0	9
Gas	17	2	0	0	0	19
Other	0	3	0	1	0	4
Oil spills	2	10	4	1	3	20
Oil volume (thousand barrels)	18.5-780	84-135.4	175	2.6	9.2-9.7	290-1,100
Deaths	23	33	0	0	0	56
Injuries	7-8	91-100	0	0	0	98-108
Fires	7	12	0	1	0	20
Major rig/platform damage	4	9	0	2	0	15
Duration	2 hrs.-5.5 mos.	10 min.-4.5 mos.	1-13 days	1 day	1-3 days	10 min.-5.5 mos.

Sources: University of Oklahoma Technology Assessment Group, *Energy Under the Oceans: A Technology Assessment of Outer Continental Shelf Oil and Gas Operations* (Norman: University of Oklahoma Press, 1973), using U.S. Geological Survey, U.S. Coast Guard, *Offshore*, and *Oil and Gas Journal* data.

Since Santa Barbara, three major production platform accidents have occurred in the Gulf of Mexico, the Shell accident (1970), the Chevron accident (1970), and the Amoco accident (1971).

The diminishing number of drilling accidents since 1968 reflects improvements in both technology and practice. Recording and reporting practices with respect to oil spills have improved greatly. The frequency of production accidents has not decreased so markedly, perhaps because old offshore production facilities and pipelines do not, in all instances, meet the specifications now called for in new facilities and pipelines.

1. OIL SPILLS (2)

Although accidents during offshore operations account for only a small portion of the oil that is spilled, locally they can be significant. Their frequency and magnitude and the fate and effects of the oil are important factors in OCS development decisions.

The most important general features of oil spill statistics from OCS operations are the following:

- The size range of individual spills is extremely large, from a fraction of a barrel to over 150,000 barrels.

- Most spills are at the low end of this range; in 1972, 96 percent were less than 24 barrels (1,000 gallons) and 85 percent were less than 2.4 barrels (100 gallons).

A few very large spills account for most of the oil spilled.

These facts are highlighted in order to point out the meaninglessness of estimating "average" amounts of oil that might be spilled at particular steps in the development process. Amounts spilled can vary by a factor of one million, and single large spills distort the statistical distribution of spill magnitudes. Further, as shown in Table IIIB-2, fluctuations from year to year are quite large.

Certain patterns emerge from the statistical analysis of oil spills for the four major sources of offshore oil pollution. Table IIIB-3 shows remarkable similarity in the number of oil spills in each volume category for 1971 and 1972. The data suggest that the same processes, equipment inadequacies, and operator errors are causing the spills. Computer Sciences Corporation, under contract to the Environmental Protection Agency, recently analyzed the failures and errors that have caused these spills. Although restricted by the limited data base, the study suggests that remedy of certain technological and operation inadequacies could significantly reduce the number and size of oil spills. Similarly, the U.S. Coast Guard has analyzed its oil spill data and is incorporating the results into the Federal inspection and enforcement program.

2. PLATFORMS AND PIPELINES (2)

Between 1964 and 1972, there were relatively few large spills from platforms and pipelines (Table IIIB-4 lists the spills of more than 1,000 barrels of oil). For an oil field find of medium size, there is about a 70 percent chance that at least one platform spill over 1,000 barrels will occur during the life of the field. For a small oil field find, there is over a 25 percent chance of one platform spill over 1,000 barrels, and for a large oil find, there is over a 95 percent chance of a platform spill over 1,000 barrels during the life of the fields. The probability of pipeline spills follows the general pattern exhibited by platform spill statistics. Figure IIIB-1, which shows the volume of oil handled on a platform between successive spills, indicates that there is about a 40 percent chance that 250 million barrels of oil will be handled between large spills. If a large platform spill does occur, there is an 80 percent chance that the volume will exceed 2,380 barrels and a 35 percent chance that it will exceed 23,800 barrels.

Figure IIIB-1 also shows that the probability of successive spills increases rapidly as the size of the find increases. Conversely, this means that large spills will occur more often -- for an equal increase in probability of a spill, 4.5 years will elapse in a small find and only 1.0 year elapse in a large find. Biologically, the time between large spills may be at least as important as the number of such spills.

TABLE IIIB-2

OIL SPILL STATISTICS
(Barrels)

Type of Spill	1971	1972
Petróleum industry-related spills		
Terminal		
Number	1,475	1,632
Volume	125,800	54,700
Ships (offshore)		
Number	22	32
Volume	400	51,600
Offshore production facilities		
Number	2,452	2,252
Volume	15,600	5,700
Onshore pipeline		
Number	74	162
Volume	8,700	29,300
Total		
Number	4,023	4,078
Volume	150,500	141,300
All spills		
Number	7,461	8,287
Volume	205,000	518,000

Source: The Massachusetts Institute of Technology Department of Ocean Engineering, 1974, "Analysis of Oil Spill Statistics," prepared for the Council on Environmental Quality under contract No. EQC330, using U.S. Coast Guard data.

TABLE IIIB-3

Petroleum Industry-Related Oil Spill Volumes
[Gallons][1]

Facility	0-1	1-10	10-100	100-1,000	1,000-10,000	10,000-100,000	100,000-1,000,000	1,000,000-10,000,000
Terminal								
1971	384	247	458	282	77	19	7	1
1972	351	347	544	298	71	16	5	0
Ship (offshore)								
1971	4	6	8	0	4	0	0	0
1972	15	2	10	3	0	0	1	1
Pipeline								
1971	222	403	496	257	41	13	2	0
1972	15	24	61	61	32	7	3	0
Platform								
1971	227	304	395	146	13	2	0	0
1972	431	784	728	244	20	4	0	0
Total								
1971	837	960	1,357	685	135	34	9	1
1972	812	1,157	1,343	606	123	27	9	1

[1] Forty-two gallons equals 1 barrel. Gallons, rather than barrels, are used to illustrate the fact that most spills involve a small volume of oil.

Source: The Massachusetts Institute of Technology Department of Ocean Engineering, 1974, "Analysis of Oil Spill Statistics," prepared for the Council on Environmental Quality under contract No. EQC330, using U.S. Coast Guard data.

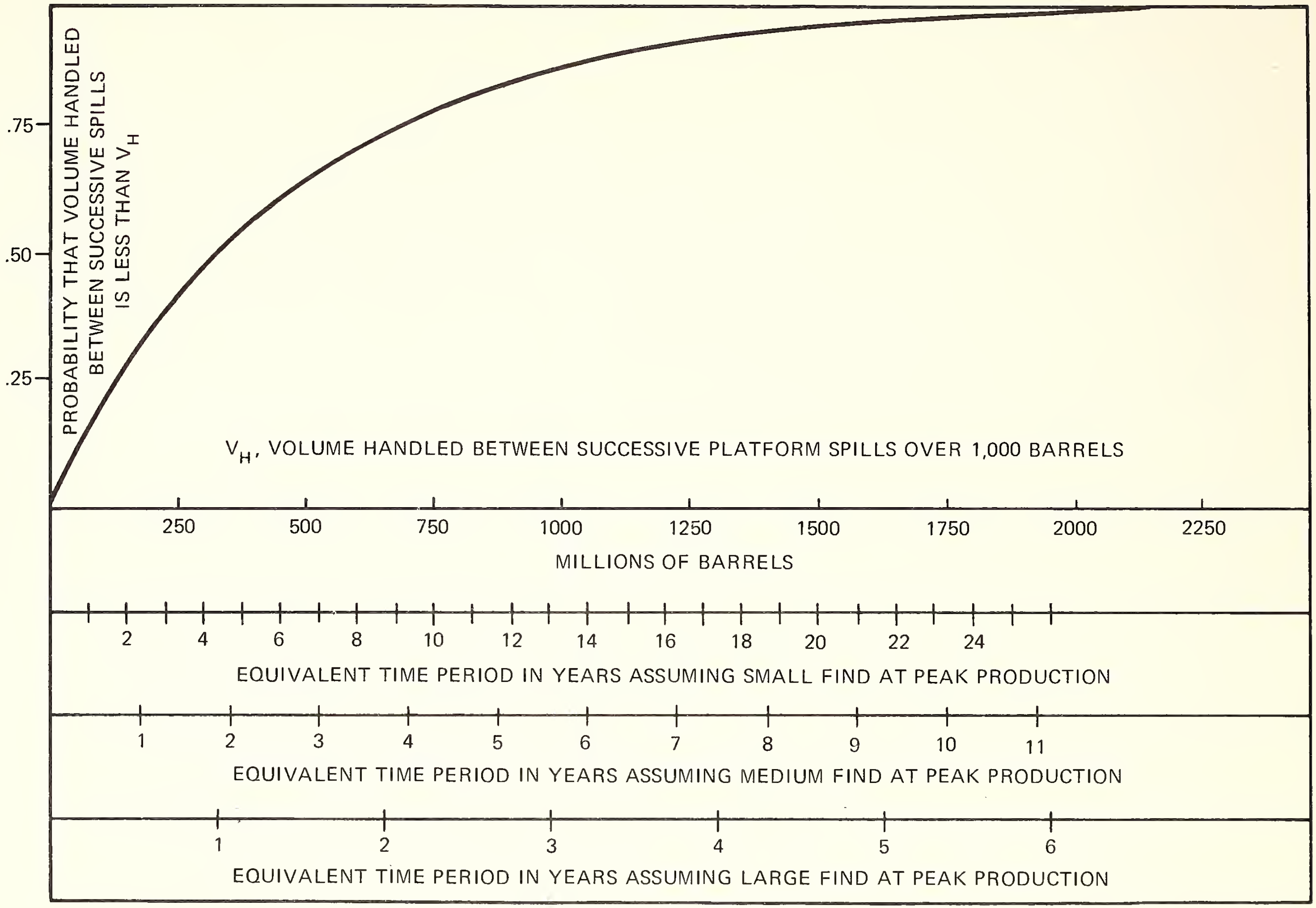
TABLE IIIB-4

Major Oil Spills from Offshore Production Facilities, 1964-1972[1]

	Cause	Date	Amount reported (barrels)
Offshore platforms			
Union "A," Santa Barbara	Blowout	January 28, 1969	77,400
Shell ST 26 "B," La.	Fire	December 1, 1970	52,400
Chevron MP 41 "C," La.	Fire	March 10, 1970	30,950
MP gathering net and storage, La.	Storm	August 17, 1969	12,200
Signal SS 149 "B," La.	Hurricane	October 3, 1964	5,000
Platform, 15 miles offshore	—	July 20, 1972	4,000
Continental EI 208 "A," La.	Collision	April 8, 1964	2,600
Mobil SS 72, La.	Storm	March 16, 1969	2,500
Tenneco SS 198 "A," La.	Hurricane	October 3, 1964	1,600
Offshore pipelines			
West Delta, La.	Anchor dragging	October 15, 1967	157,000
Persian Gulf	Break	April 20, 1970	95,000
Coastal channel, La.	Hit by tug prop	October 18, 1970	25,000
Chevron MP 299, La.	Unknown	February 11, 1969	7,400
Gulf ST 131, La.	Anchor dragging	March 12, 1968	6,000
Coastal channel, La.	Equipment failure	December 12, 1972	3,800
Coastal waters, La.	Leak	March 17, 1971	3,700
Coastal channel, Tex.	Leak	November 30, 1971	1,000
Coastal channel, La.	Leak	September 28, 1971	1,000

[1] Over 1,000 barrels.

Source: The Massachusetts Institute of Technology Department of Ocean Engineering, 1974, "Analysis of Oil Spill Statistics," prepared for the Council on Environmental Quality under contract No. EQC330.



Source: The Massachusetts Institute of Technology Department of Ocean Engineering, 1974, "Analysis of Oil Spills," prepared for the Council on Environmental Quality under contract No. EQC330.

Figure IIIB-1 Cumulative Volume of Oil Handled Between Platform Spills Larger than 1,000 Barrels

3. TANKERS (2)

About 98 percent of all the oil spilled accidentally by vessels is from incidents over 1,000 barrels. Most large tanker spills occur within 50 miles of land. Most result from groundings, rammings (the vessel hits a fixed structure), or collisions. Groundings and rammings occur nearshore. Collision frequency depends on traffic density, which is highest nearshore.

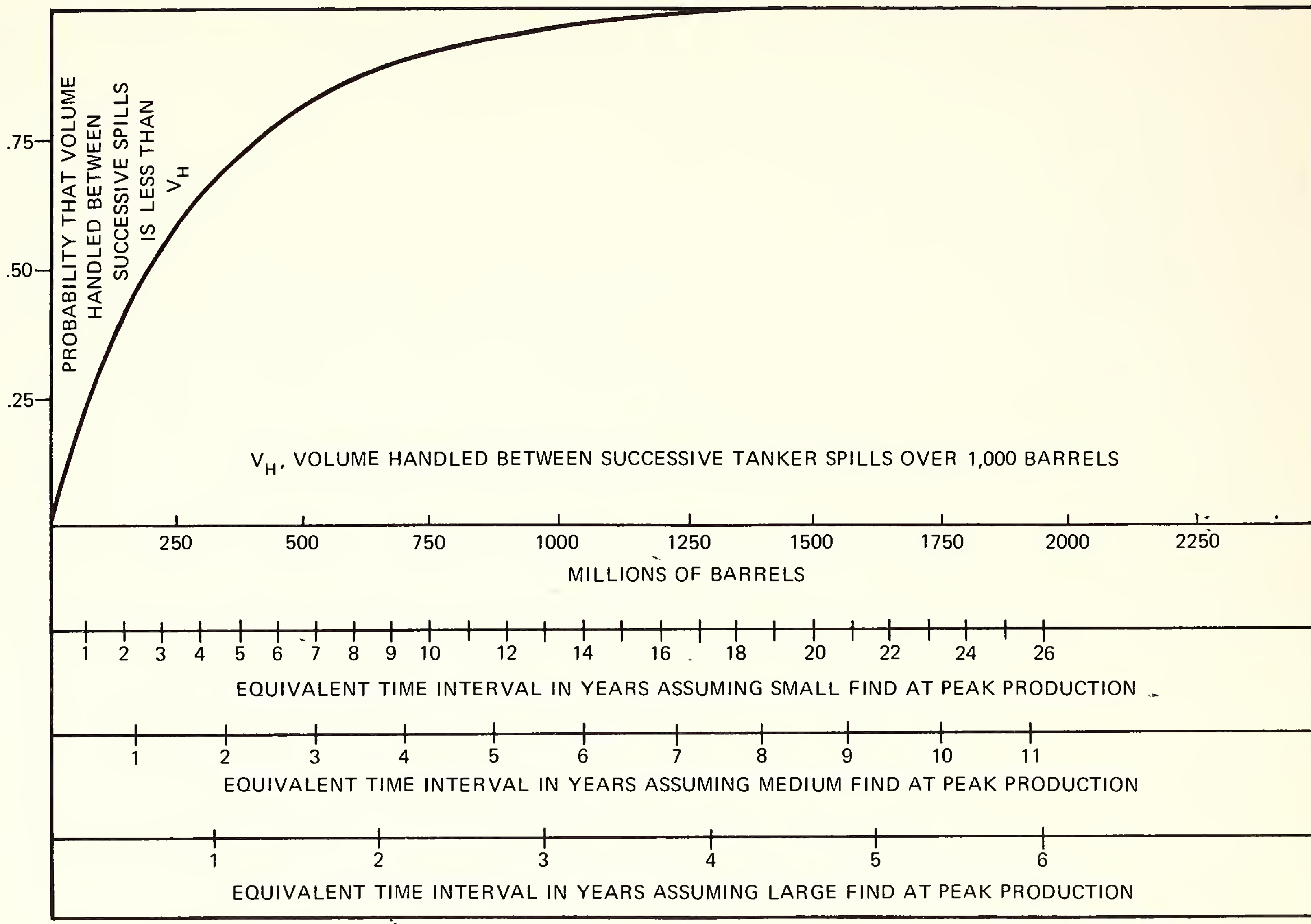
Analysis of tanker spill statistics indicates that, if tankers are used to transport the oil to shore, the probability that there will be one tanker spill over 1,000 barrels is about 27 percent during the life of a small find, about 85 percent for a medium find, and nearly 100 percent for a large find. As the size of the find increases, so do the number of expected spills and the overall probability that a spill will occur (see Figure IIIB-2).

The possibility of more frequent or larger oil spills resulting from the use of single point moorings (SPMs) has also been analyzed. One might expect more spillage at SPMs than at fixed berth facilities because the SPM adds ship motion, flexible hoses subject to wave action, and possible loss of mooring to normal loading operations.

4. TOTAL VOLUME OF OCS OIL SPILLS (2)

The total volume spilled over the life of a field, although not as important as the frequency and magnitude of individual spills, is of interest. Table IIIB-5 shows that the number and total volume of spills for platforms, pipelines, and tankers are of the same order of magnitude for a given field size. Platforms have the lowest frequency and volume and tankers the highest.

In interpreting these data, one must keep in mind that they are based on past experience and do not adjust for future improvements or production economics. If low-productivity OCS fields are discovered, replacement of pipelines 15 to 20 years into the field's life may be uneconomical; this could lead to higher incidence of pipeline leaks. The tanker spills include those from ships registered in all nations; however, U.S.-flag ships have a better overall record.



Source: The Massachusetts Institute of Technology Department of Ocean Engineering, 1974, "Analysis of Oil Spills," prepared for the Council on Environmental Quality under contract No. EQC330.

Figure IIIB-2 Cumulative Volume of Oil Handled Between Tanker Spills Larger than 1,000 Barrels

TABLE IIIB-5 OIL SPILLED OVER THE LIFE OF A FIELD

	Number of Spills	Total Volume (barrels)
Small Find		
Platform	0.28	7,200
Pipeline	0.31	13,900
Tanker	0.41	19,900
Medium Find		
Platform	1.3	33,300
Pipeline	1.4	62,900
Tanker	1.9	92,400
Large Find		
Platform	4.7	120,500
Pipeline	5.2	233,300
Tanker	6.9	335,700

Source: The Massachusetts Institute of Technology Department of Ocean Engineering, 1974, "Analysis of Oil Spill Statistics", prepared for the Council on Environmental Quality under contract No. EQC330.

Although the M.I.T. approach does not consider average spillage rates valid, mean spill rates were derived at the request of the Council, M.I.T.'s computed ratio of the mean spill rate to the total volume of oil handled for platforms is 0.006 percent, for offshore pipelines is 0.011 percent, and for tankers is 0.016 percent.

5. CHRONIC DISCHARGES (2)

Several routine OCS operations result in discharges of oil and other materials to the water. Unlike that for accidental spills, their probability is 1.0 -- they have a 100 percent chance of occurring.

Securing production platforms with pilings or anchors, anchoring vessels, and burying pipelines offshore disturb bottom sediments and increase turbidity.

As previously described, drilling mud is separated from the drill cuttings, and the mud is recycled and reused. Drill cuttings are discharged overboard; and mud discharge is generally limited to small amounts of material which cannot be effectively separated from the drill cuttings. Drill cuttings are shattered and pulverized sediment and native rock. Drilling mud may consist of such substances as bentonite clay, caustic soda, organic polymer, proprietary defoamer, and ferrochrome lignosulfonate. During the course of drilling an average 15,000 foot well, a maximum of 110 tons of commercial mud components would be used and 950 tons of drill cuttings generated.

Drill cuttings are discharged overboard; drilling mud is not routinely discharged. Heavy, highly treated drilling muds are quite expensive and are efficiently recycled and reused. Mud discharge is generally limited to small amounts of materials which cannot be effectively separated from the drill cuttings. The actual amounts of muds which are actually discharged are highly variable and difficult to determine.

During production operations, waters from the geological formations are often released. These formation waters may be fresh or may contain mineral salts such as iron, calcium, magnesium, sodium, carbonate and chloride. Their discharge increases the mineral content and lowers dissolved oxygen levels in the area of operations. The waters often contain small amounts of oil.

6. VESSEL GENERATED POLLUTANTS (2)

Vessels involved in OCS oil and gas drilling, support, and service operations generate certain chronic pollutants which are common to vessels in general. A discussion of these pollutants follows:

a. Sewage

A synthesis of current information concerning the treatment and disposal of vessel sanitary wastes is provided in "Treatment and Disposal of Vessel Sanitary Wastes - A Synthesis of Current Information."[7] For the purposes of this statement the following definitions and policy hold:

- Sewage - human body wastes and the wastes from toilets and other receptacles intended to receive or retain body wastes (35 gallons/man/day);

- Domestic Wastewater - wastes from sinks, showers, laundries and galleys (35 gallons/man/day);

- Sanitary Wastewater - sewage and domestic wastewater (70 gallons/man/day), daily per capita weight (grams) BOD 90 and SS 106;

- The discharge of sewage and domestic wastewater must be in compliance with the Federal Water Pollution Control Act of 1972, Annex IV of the 1973 International Marine Pollution Convention, and the applicable EPA and U.S. Coast Guard regulations.

A marine sanitation device includes any equipment for installation onboard a vessel which is designed to receive, retain, treat or discharge sewage and any process to treat such sewage. Sewage is generated aboard ship at approximately 35 gallons/man/day. The characteristics of vessel sewage are the physical and chemical properties of the material and the biological content and interactions that take place between various elements of the material. Excluding the flush water, the input to toilets and urinals comprises urine, feces, paper, and occasionally other materials for which the receptacles are not intended. Urine has a specific gravity of 1.002 to 1.035 and a pH of 4.6 to 8.0. The water content of feces ranges between 65 percent and 85 percent and the pH from 6.9 to 7.7. The average daily per capita accumulation of body waste has a weight of approximately 1,620 grams, a specific gravity of 0.98 and a pH of 6.7. Approximately 10 percent of the mixture comprises solids of which 65 percent are dissolved leaving a weight of 90 grams of undissolved solids. The discharge of a ship's sanitary wastes into the open ocean does not constitute as great a hazard to the marine environment as sanitary waste discharges in coastal waters. The fact that the oceans and seas of the world contain living creatures that also generate excretions must be taken into consideration when weighing the relatively small amount of biodegradable sewage discharged from a vessel operating in the open sea.

Direct overboard discharge of untreated or inadequately treated sewage into relatively shallow territorial waters is objectionable and may render the water unhealthy for contact recreational sports and be inhibitive to aquatic life. Such discharge introduces floating and suspended solids, increases turbidity, and causes discoloration of the water. Suspended solids reduce the transparency of water to sunlight which is needed for phytoplankton and attached algae photosynthesis. Settleable solids can form sludge blankets upon river, estuary or coastal beds which produce undesirable changes in bottom life and subsequently decay, producing gases with objectionable odors. Sewage wastes exert an oxygen demand that reduces

free oxygen in the waterway thus inhibiting the normal activities of aquatic life. These wastes may also contain pathogens that can infect people with such diseases as typhoid fever, dysentery, hepatitis and cholera. Shellfish beds must be closed when significant concentrations of fecal bacteria become evident. A polluting sewage discharge may be characterized as that which:

. results in unsightliness (scum, floating material, oil, foam);

. results in noxious odors;

. results in sludge deposits;

. causes damage to properties of the environment;

. is chemically toxic to human, animal or plant life;

. yields pathogenic organisms;

. causes excessive oxygen depletion;

. stimulates excessive algal and water-weed growth.

It is not feasible to measure all the polluting elements in a discharge. However, there are measurements of certain elements that yield enough information to ascertain whether a discharge has the potential of seriously polluting a waterway. These are measurements of biochemical oxygen demand (BOD), suspended solids (SS), number of coliform bacteria and pH value. BOD is a measure of the quantity of oxygen required by micro-organisms to stabilize biodegradable materials in water. This demand is exercised by organisms in both the suspended and dissolved solid elements of sanitary waste. The accepted standard method of BOD measurement requires a five-day incubation time; a more precise symbol of this quantity is BOD-5. Other assessments of oxygen can be obtained by measuring related parameters such as dissolved oxygen content, total organic carbon content, total oxygen demand, or chemical oxygen demand as an indication of the quantity of pollutants present. The weight of suspended solids in a given volume of sewage is determined by filtering, drying, and weighing the residue. The suspended solids in a sewage sample are indicative of pollution potential in the form of unsightliness, sludge deposits, and noxious odors that may occur in the waterway.

It is recognized that untreated sewage from vessels, while not the chief contribution of the sewage contamination of our waterways, is certainly additive to pollution from communities along these waterways and from recreational boats. Under the authority of the Federal Water Quality Improvement Act (Section 13) of 1970, the Environmental Protection Agency (EPA) has established standards (Federal Register, Friday,

June 23, 1972) of performance for marine sanitation devices to prevent the discharge of untreated or inadequately treated sewage into or upon the navigable waters of the United States from vessels. Detailed EPA standards (8) can be summarized as follows:

- The long range standards are designed to bring about an end to the discharge of wastes - treated or not - into navigable waters.

- The EPA standards will become effective for new vessels two years after the Coast Guard implementing regulations are established and for existing vessels five years from that time.

- Incentives are provided for vessel owners to equip their vessels with marine sanitation devices certified by the Coast Guard.

- Coast Guard certification calls initially for devices which will as a minimum requirement reduce fecal coliform bacteria to no more than 1,000 per 100 milliliters and prevent the discharge of visible floating solids.

- Existing vessels, with certified sanitation devices installed within three years after the initial standards and regulations are promulgated, would be allowed to retain such devices for their useful life. If the equipment is installed between three and five years after the date of promulgation, it could be used for eight years after the date of promulgation.

- States may ask EPA to issue regulations completely prohibiting vessels from discharging any sewage - whether treated or not - into State waters that require special protection to meet water quality standards and are part of the Nation's navigable water system.

Significant research and development advances are presently being made in the field of shipboard sewage (and sanitary waste) treatment. Section 70 of the MarAd Standard Specifications for Merchant Ship Construction (9) has been modified and requires the installation of certified marine sanitation devices. Certification procedures and design and construction requirements of the Coast Guard are contained in Title 33, Part 159 of the Code of Federal Regulations. Sewage generated aboard rigs and platforms is regulated by OCS Order No. 8 of the U.S. Geological Survey.

b. Domestic Wastes (6)

Domestic waste means wastewater from laundries, galleys, showers, sinks, etc. The most significant domestic wastes environmentally are laundry detergents and liquid garbage.

Domestic waste is generated aboard ship at approximately 35 gallons/man/day. Because of the very low concentrations of detergents and the nature of liquid garbage in domestic waste waters, these wastes are not of great environmental significance. Polluting domestic waste discharges have many of the same characteristics as polluting sewage discharges.

c. Garbage (6)

All operating vessels will daily dispose of quantities of garbage in various ways. Although aesthetically unpleasant, over-board discharge of biodegradable garbage in the amount normally produced by vessels in the ocean is not considered hazardous to the environment and may in fact be beneficial to a certain extent by providing additional nutrients to an area where normal low nutrients may be limiting to abundant phytoplankton growth.

In port, on the other hand, local ordinances usually forbid garbage being dumped overboard. Consequently, the garbage and trash are either collected for disposal ashore, or they are contained aboard ship for overboard discharge after the vessel puts to sea. Traditionally, MarAd has subsidized the installation of garbage grinders and, in addition, is considering the possibility of treatment of the effluent in combination with sewage treatment or removal by incineration.

d. Stack Exhaust Emissions (6)

Stack emissions are usually considered in terms of: (1) smoke appearance or density; (2) quantity and size of particulate matter; and (3) quantity and noxious characteristics of gases, fumes or vapors emitted such as sulphur oxides, nitrogen oxides and unburned hydrocarbons. Shipboard sources of these emissions include the diesel propulsion systems, auxiliary boilers, auxiliary diesel engine driven equipment, and incinerators.

e. Noise (6)

The vessels engaged in offshore oil and gas drilling operations, such as the service vessels, generate noise in their operation

primarily from their whistles, from the operation of diesel engines, and from other machinery such as pumps. With exception of the noise from whistles, these sounds are limited to the vicinity of the vessel and are of a relatively low level, being muffled by the structure of the vessel itself.

f. Oil

Oil spills can occur from bilge pumping, fuel tank leaks, and bunkering operations:

- Bilge pumping - the bilge is the lowest point of the vessel's inner bottom and is used to collect oily wastewater from machinery spaces. This waste water must be discharged at regular intervals.

- Leaks - Leaks occur due to lack of complete hull integrity. Welded construction and double bottoms tend to reduce leaks to a negligible quantity.

- Bunkering operations - Refueling discharges are caused by (1) mechanical faults, (2) design faults, (3) human error.

C. HISTORY OF OCS PETROLEUM DEVELOPMENT ACCIDENTS

In any complex industrial operation involving heavy equipment, flammable materials, work at sea, large number of employees, and reliance on complex technology, it is inevitable that accidents will occur. Proper analysis of these accidents is a complex problem. The history of OCS petroleum development accidents provides a substantial data base for estimating the frequencies of future accidents.

1. NATURAL GAS LEAKS ASSOCIATED WITH BLOWOUTS (10)

Information furnished by the Geological Survey for the period 1956 to 1973 lists 38 gas leaks associated with well blowouts during OCS petroleum development operations in the Gulf of Mexico. No gas leaks have been reported from th California OCS. Eleven of these incidents in the Gulf of Mexico involved fires and five were associated with oil or condensate spills. The duration of these blowouts ranged from two hours to over seven months. No estimates of the amount of gas lost have been made. Degradation of air quality is the primary environmental impact of gas leaks with or without fires. Several gas leak incidents also resulted in injury and death of members of the OCS platform crew and in damage or loss of valuable equipment.

2. OIL SPILLS GREATER THAN FIFTY BARRELS ON SIZE (10)

Data supplied by the Geological Survey for the period 1964-1974 (includes only first quarter of 1974), list 45 oil spill incidents of 50 barrels or more of oil and condensate resulting from Federal OCS oil and gas operations. Most occurred in the Gulf of Mexico. Only one of these incidents occurred in the California OCS operations -- the blowout on Platform A in the Santa Barbara Channel. In the following discussion of oil spills by type of accident, this history of 45 OCS accidents will be used to provide an estimate of throughput oil spill rates for each type of accident.

a. Pipeline Accidents

During OCS operations, more oil has been spilled from pipeline accidents than from all other types of OCS petroleum production accidents. The largest OCS oil spill occurred in October 1967 when a vessel underway during a storm dragged its anchor, which was inadvertently left out, across a pipeline. The snagged pipeline severed;and the resulting spill went undetected for nearly two weeks, releasing over 160,000 barrels of oil into the ocean about 20 miles west of the mouth of Southwest Pass, Mississippi River Delta, Louisiana. In March of 1968, another anchor dragging incident resulted in a 6,000 barrel spill. In February of 1969, a pipeline leak of undetermined cause released over 6,500 barrels into the sea.

Starting in 1969, several actions were undertaken to reduce the chances of such accidents and to reduce the volume of these spills. Burial of all new common carrier pipelines with a minimum cover of three feet (10 feet in shipping fairways and anchorage areas) was required by the Bureau of Land Management (BLM) for the right-of-way permits in water depths of less than 200 feet. The water depth requirement for pipeline burial may be increased to 250 feet for certain OCS areas. In water depths of less than 200 feet, only the lines in the gathering system between adjacent platforms of a particular oil or gas field may remain unburied. Permits to construct these gathering lines are granted by the Geological Survey, and the decision on whether to require burial is made on a case-by-case basis. These administrative actions have substantially reduced the risks of futurepipeline ruptures due to anchor dragging.

Additional safeguarding of OCS pipelines and mitigation of accidental spillsare provided by regulations promulgated by the Office of Pipeline Safety (OPS), of the Department of Transportation. Petroleum pipelines in offshore areas are required to be coated with tightly banded materials impervious to moisture, followed in many cases by a layer of dense concrete for mechanical and corrosion protection (49 CFR Parts 192 and 195). To protect against electrolytic corrosion,

impressed currents of sacrificial anodes are required. Regulations by OPS also mandate use of a continuous line pressure monitoring with some type of built-in alarm or automatic shut-down system. The OPS regulations requiring protection devices and pressure monitoring systems, coupled with regular inspection of the pipeline route for leaks and other irregularities, should also substantially reduce the risk of pipeline oil spills.

Other features used by industry serve to further mitigate against accidents: continuous metering systems, automatic high pressure shut-downs, and remotely controlled mainline block valves that can isolate sections of the line. The latest pipe-laying and monitoring techniques, combined with modern materials and equipment, will further help to insure that the pipelines used in the various OCS areas will function at an acceptably high level of reliability.

Prior to institution of the new pipeline burial requirements, the spillage rate from pipeline accidents was .00624 percent of total production. With the new regulations, this spillage rate has been substantially reduced to .0017 percent of total production in the period since 1970. Although the new regulations and improved industry practices have brought the spillage rate down, the problem of pipeline spills from anchor dragging has not been completely removed. As a part of the pipeline management program, the costs and benefits of extending pipeline burial systems will be investigated.

Caution should be inserted at this point. The improved performance of pipelines now in existence may not continue. Industry spokesmen have estimated that 48 percent of all pipeline leaks occur in lines that have been in use for 15 years or more. In established offshore petroleum fields where older pipelines are present, corrosion may be in an advanced state. Such pipelines may be poorly buried, if at all, and all of the above mentioned safety and control features may not apply. If serious spillage should occur from some of these older pipelines, the statisticalimprovement of pipeline performance could be reversed. However, in each future OCS lease sale, all of the safety and control requirements discussed above will be enforced. Therefore, it may be expected that these pipelines should function adequately, since they will be new lines.

b. Oil and/or Gas Well Blowouts During Drilling

Data from the Geological Survey lists a total of 44 blowouts in Federal OCS petroleum operations during the 1964 - 1974. Only 17 of these blowouts resulted in oil spills of 50 barrels or more. Examination of OCS statistics indicates one blowout per 2,860 wells drilled (or .035 percent of wells drilled blowout), spilling an average of 2,100 barrels of oil and condensate per blowout. The Santa Barbara oil spill provides an example of a blowout during drilling.

Santa Barbara Spill

On January 29, 1969, a blowout occurred below Platform A about six miles southeast of Santa Barbara, California. Thousands of gallons of oil spewed into the Santa Barbara Channel, as men worked feverishly to regain well control. This blowout and spill occurred through a pre-existing fault in the ocean floor adjacent to the well. The apparent cause was accidental injection of high pressure gas from a deep reservoir into the shallow reservoir sands. Pressure built up in the shallow reservoir sands until the overlying rock layer ruptured. This rupture formed a fissure zone through which the oil moved up to the seabottom and escaped into the overlying waters. The blowout continued for 10 days, until the well was choked with cement on February 7, 1969. The reprieve was only momentary and spillage began anew a few days later. Some seepage continues to this day.

The Geological Survey estimated the initial spillage from the Santa Barbara blowout totaled 420,000 gallons (10,000 barrels). Other estimates of the initial spillage range from 2,940,000 gallons to 29,400,000 gallons (70,000 to 700,000 barrels)* An additional seepage of 10,325 barrels occurred between February 7, 1969 and December 31, 1972. During 1973, this seepage continued at a rate of 1,825 barrels per year.

c. Oil Spills Resulting from Explosions and Fires

Fires have always been a major hazard in the petroleum industry. OCS operations are no exception. Most fires are ignited by arcing electrical equipment and overheated mechanical devices. More rarely, lightning or static electricity is the cause of ignition. Sometimes, platform fires result from accidental ignition of stored fuel, solvents, or heat exchanger fluids. If caught soon enough, these small fires are usually controllable. If a storage tank or well catches on fire, the resulting inferno can cause major structural damage. Adjacent producing wells may have their piping severed and thereby contribute additional fuel to the fire. The majority of fires are quickly extinguished with little or no damage. Uncontrollable fires causing major structural damage usually involve numerous wells in the fire and all too often result in multiple fatalities.

*Testimony of Dr. Carl H. Oppenheimer, OCS Public Hearing of August 23, 1972, New Orleans, Louisiana.

The Geological Survey has reported 113 explosions and fires in the 1964-1974 period of Federal OCS activities. Most of these fires were extinguished before serious damage and pollution occurred. Only six of these accidents resulted in oil spills. However, the volume spilled in two of these incidents was very large, 30,500 barrels from one and 53,000 barrels from the other. The total volume spilled from all explosions and fires is approximately 85,000 barrels. Perhaps of greater significance is the injury of 120 men and the death of and additional 59.

Due to the serious threat of injury and death, industry is typically very cautious about OCS explosions and fires. However, due to the history of fire caused massive oil spills, OCS orders were amended to require extra safety precautions to reduce the potential for future fire related oil spills. To eliminate blowouts due to malfunctioning velocity-actuated downhole safety devices, OCS Order No. 5 requires surface actuated safety devices. If all wells are successfully closed during fires and explosions, the size of future fire caused oil spills should be limited to the volume of flammable stored on the platforms when the fire started. Since 1971, explosion and fire accidents have not resulted in more than minimal oil spills.

d. Oil Spills Caused by Severe Storms - Hurricanes

In the history of Federal OCS oil and gas activities, there has been only one severe storm which caused significant oil spillage. On October 3, 1964, a hurricane passed over the waters off central Louisiana destroying three OCS platforms. The total volume of oil spilled in this hurricane was approximately 12,000 barrels. All of this spilled oil was from tanks used to store produced oil prior to trans-shipment by barge.

Since 1964, three major hurricanes have hit the extensive offshore petroleum production areas off Louisiana. While causing financial damage to the offshore industry, they have not resulted in major pollution incidents from operations in Federal waters. When the Weather Service advises that a hurricane or serious tropical storm is imminent, all oil and gas facilities in or adjacent to the path of the storm are evacuated. Before evacuation, all surface equipment and wellhead controls are shut-in. In addition, blank tubing plugs are set in as many wells as possible to further reduce the possibility of pollution in the event the well is damaged.

The efficiency of these safety precautions was amply demonstrated during Hurricane Camille. On August 17, 1969, Camille passed along the eastern flank of the Mississippi Delta of Louisiana and into the Mississippi Gulf Coast. Camille's top winds were estimated at 201.5 miles per hour, and the storm surge raised the sea level 22.6 feet above normal at Pass Christian, Mississippi. During Camille's onslaught, one production platform was destroyed, and three were damaged. No significant oil spillage occurred.

The severity of storms occurring in the various other OCS areas are substantially different from those encountered either in the Gulf of Mexico or off California. With only one incident on record, no generalization should be made concerning the maximum spillage which future severe storms may cause.

e. Oil Spills Caused by Ships Colliding with Platforms

Commercial vessels can collide with OCS platforms, typically causing substantial damage to both the vessel and the platform. This section deals only with the oil spilled from the platforms. The oil spilled from the vessels colliding with the platforms is dealt with in the next subsection. Accident records indicate only one instance of a significant oil spill from a platform caused by ship collision. In April 1964, a freighter off central Louisiana struck and damaged a platform, resulting in a fire and loss of 2,560 barrels of oil into the sea. A history of one accident does not provide sufficient information to allow generalization about the magnitude or frequency of future collision related oil spills.

f. Tanker and Tank Barge Accidents and Operations

Accidental oil spills from tankers and tank barges, as well as oil discharged during normal operations, are probably the largest sources of oil spills in the U.S. There are a wide variety of data sources for tanker accidents world-wide, and estimates of tanker and tank barge spill rates vary widely. For example, the Bureau of Land Management has often used 1971 data for world-wide waterborne petroleum transports carried by the U.S. tanker fleet. This data indicates a spill rate of .08 percent of each cargo. The Massachusetts Institute of Technology, using a more complex data base, computed a ratio of mean spill rate to the total volume of oil handled of .016 percent. No matter which of the above estimates of tanker oil spill rates is used, the result is the same. Transportation of oil in tankers and tank barges is hazardous. The high oil spill hazard to tanker and tank barge transportation of petroleum is a very important factor in distinguishing the relative oil spill hazards of the various OCS areas. If the OCS petroleum production can be piped to shore, the oil spill hazard is substantially less than the oil spill hazard when tankers and barges are used. Further, if the oil and gas production of an area has to be transported by tankers out of that area for consumption in another area, once again the operation is exposed to the higher relative hazards of tanker transportation.

It is difficult to assess the total amount of petroleum that will be spilled into the marine environment as a result of the daily operation of U.S. flag tankers and tank barges. Although there are estimates of the total amount of pollution

resulting from cargo handling, tank barge leaks, and cleaning/bunkering/ballasting/bilge pumping., (Charter, et al., (12) and Porricelli, et al., (13)), there is no breakdown according to registry. It should be noted, however, that U.S. Coast Guard regulations and standards are among the most stringent and rigidly enforced in the world.

Throughput spill rates are not the only available method for assessment of the oil spill hazards of tanker transportation of petroleum. The Massachusetts Institute of Technology performed an extensive analysis of oil spill statistics for the Council on Environmental Quality (14). See also Section IIIB. Their analysis indicated that average spill rates were almost without meaning. Therefore, they concentrated their efforts on estimating the probability of spills larger than 1,000 barrels. Analysis of tanker spill statistics indicated that approximately 98 percent of all oil spilled from vessels is from incidents over 1,000 barrels. Most large tanker spills occur nearshore and are caused by groundings, rammings (the vessel hits a fixed structure), or collisions. Groundings and rammings occur nearshore, and collision frequency depends on traffic density, which is highest nearshore.

M.I.T. expressed oil spill hazards as estimates of the probability of spills larger than 1,000 barrels. As the size of the petroleum field increases, so do the number of expected spills and the overall probability that a spill will occur. M.I.T. classified oil and gas discoveries as small finds, i.e. 500 million barrels of oil in place; medium finds, i.e. 2 billion barrels of oil in place; and large finds, i.e. 10 billion barrels in place. Using a complex worldwide data base of past tanker oil spills, M.I.T. estimated that the probability of one tanker spill over 1,000 barrels during the life of a small field, there is approximately 27 percent. During the life of a medium sized field, there is approximately an 85 percent probability of one such spill. For a large find, this probability is nearly 100 percent. M.I.T. also estimated the expected volume of spills over the life of each field size. The results were: small find 0.40 spills, 19,900 barrels; medium find 1.9 spills, 92,400 barrels; large find 6.9 spills, 335,700 barrels. The estimates of volume spilled dramatically state the oil spill hazards of tanker transportation.

g. Other Spills of 50 Barrels or More

This category is a combination of spills over 50 barrels which had causes other than those discussed above. Accident records

indicate a total of 15 such spills through 1973. Total discharge from these spills amounted to approximately 9,200 barrels. Twelve of these spills were attributed to overflow, malfunction, rupture or failure of platform piping valves or vessels.

One spill occurred during abandonment and platform removal. In this operation a well broke and spilled 500 barrels of oil. To help prevent recurrence of this type of spill, OCS operating order No. 3 requires that a redundant series of bridging devices, weighted muds, and cement plugs be placed in any well or drill hole prior to abandonment. Well and drill hole abandonments performed in this manner should provide an ample margin of protection to prevent future oil spills from abandoned wells or drill holes.

Two similar incidents, occurring in July 1971 and January 1973, caused spills totalling 7,100 barrels. Both of these were caused by damage to oil storage barges.

h. Minor Spills

Starting in 1970, the Geological Survey required reporting of oil spills less than 50 barrels in size. Since then some 5,000 such minor spills by number, volume, and source. Even though the number of minor spills each year has increased slightly during the 1970-1973 period, the total volume spilled has decreased substantially. During this same period, the total OCS petroleum varied by less than 13 percent, whereas the volume of minor spills decreased by approximately 60 percent. This substantial decrease in the volume of oil spilled in minor spills probably indicates an improvement in industry's performance in cleaning up its routine operations and thereby reducing the amount of chronic spillage.

TABLE IIIC-1 MINOR OIL SPILLS

Year	Total Number Reported	Number by Source: Drilling	Number by Source: Pro. & Trans.	Total Volume Barrels
1970	1,200	4	1,196	2,597
1971	1,250	13	1,237	2,414
1972	1,158	13	1,145	1,812
1973	1,392	10	1,382	1,857
Total	5,000	40	4,960	8,680

Note: Total OCS petroleum production during the 1970-1973 period was 1,488,242,300 barrels. Therefore, the minor spills spillage rate is 0.000583 percent.

i. Summary of Throughput Spillage Rates

Each of the eight preceding subsections dealing with oil spills from OCS operations identified the volume of oil spilled for each class of accidents. With the exception of oil spills caused by blowouts, the volume spilled can be expressed as throughput spillage rate, i.e., total volume spilled divided by total volume produced. Spill rates for blowouts are better expressed as blowouts per well drilled. This section brings all of these spillage rate estimates together. The reader is cautioned on three points.

First, as explained in detial in the preceding discussion, the quality of the data varies among the causes of accidents. For several accident categories, there are not sufficient data to allow extrapolations about expected future spill rates.

Second, it must be emphasized again that to date OCS oil and gas operations have occurred in only the Gulf of Mexico and off Southern California. The natural environmental conditions, i.e. severe storms, earthquakes, tsunamis and bottom types encountered in the frontier areas of the OCS, will differ substantially from those experienced to date. Therefore, this historical accident data provides a questionable basis for predicting accident frequencies in areas such as the Gulf of Alaska or Georges Bank.

Third, as already noted, the statistical validity of throughput spill rates is questionable. The amount spilled from the same type of accidents can vary by a factor of 10,000 or more, e.g. the largest pipeline accident spilled over 160,000 barrels of oil and the smallest significant pipeline spill was less than 100 barrels. The presence of a single large spill in the accident history can seriously distort the mean spill rate especially when changes in OCS Operating Orders have substantially reduced the chances of another large spill.

These caveats aside, the throughput spill rates are shown in Table IIIC-2.

TABLE IIIC-2

THROUGHPUT SPILL RATES

Accident Class	
1. Pipeline accidents	.00170 percent 1/

1/ Pipeline spill rate since 1970. See Section IIIC-2a. The M.I.T. estimate for offshore pipelines is .011 percent (see Table IIIB-5).

TABLE IIIC-2

THROUGHPUT SPILL RATES

Accident Class		
2. Blowouts	.00290 percent	2/
3. Explosions and Fires	.00290 "	
4. Severe storms	.00041 "	
5. Ship Collisions with Platforms	.00009 "	
6. Tanker and Tank barge	.01600 "	3/
7. Other Spills of 50 Barrels or More	.00032 "	
8 Minor Spills	.00058 "	
Total without tankers	.00890 "	
Total with tankers and without pipelines	.02320 "	
Total with both tankers and pipelines	.02490 "	

2/ Blowouts expressed as throughputs spill rate. An alternative expression is .035 percent of wells drilled blowout with an average spill of 2,100 barrels per blowout.

3/ The M.I.T. estimate of tanker throughput spill rate.

3. MAJOR OIL SPILLS AND THE MARINE ENVIRONMENT (10)

Oil spills can be transported many miles from the site of an accident. How waves passing underneath an oil slick, winds blowing over an oil slick, and currents in the underlying water combine to move an oil spill is incompletely understood. Nevertheless, movement of oil spills from the sites of accidents to coastal areas is a prime concern. M.I.T. in their work for CEQ concentrated their efforts on estimating probabilities of OCS oil spills reaching coastal areas. See Reference 2 to this Chapter. The primary concern in this section is how oil spreads from the source of a spill, and further, on the processes which change the characterisitics of the oil as it weathers.

Consider a large volume of oil suddenly released on the surface of the sea. Presume that there are no physical boundaries restricting the spread of this oil in horizontal directions. Under these conditions, which are appropriate for OCS oil spills, the spreading of the oil will occur at different rates as the time from the spill increases. The details of the various forces affecting these spreading rates are beyond the scope of this discussion. Readers interested in these details are referred to the Georges Bank Petroleum Study, Volume II, Massachusetts Institute of Technology, Report No. MITSG 73-5, February 1, 1973. For this discussion, it is sufficient to report the results of the MIT analysis. Figure IIIC-1 is taken

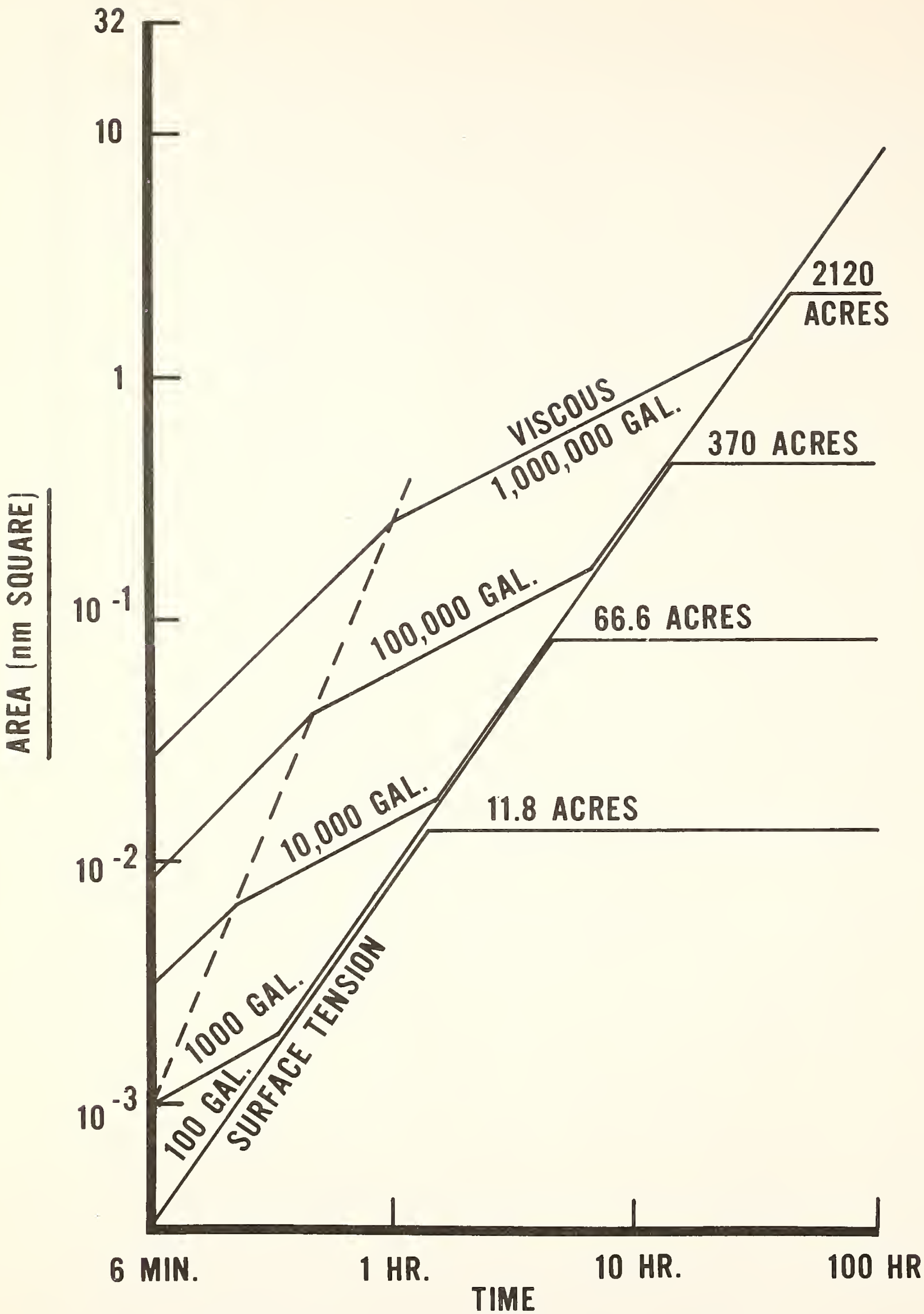


FIG. III C-1 REPRESENTATIVE SPREADING HISTORIES FOR FIVE SPILL VOLUMES, AREA COVERED VS. TIME FROM SPILL

TYPICAL CRUDE OIL CHARACTERISTICS

from the MIT report and shows the following areas of oil spreading for various sized oil spills: 1,000 gallon spill, 11.8 acres in slightly over one hour; 10,000 gallon spill, 66.6 acres in approximately seven hours; 100,000 gallon spill, 370 acres in slightly over 10 hours; and 1,000,000 gallon spill, 2,120 acres in approximately 75 hours. These areas of spread are for one spill continuing as one spreading mass. At some time in the spreading process, variations in the winds, waves and currents usually cause a large continuous spill to break up into several large patches surrounded by many smaller patches. As time goes on, the large patches will separate from one another. This will increase the width of the patch swept by the spill. Apparently such processes were at work on the Santa Barbara oil spill. An oil slick spread over approximately a thousand square miles extending from northwest of Santa Barbara to Ventura and Oxnard on the South and offshore beyond the Channel Islands.

Petroleum in seawater is altered chemically by evaporation, dissolution, chemical oxidation, photochemical reactions and microbial action. These processes are often referred to collectively as weathering. How fast crude oil weathers is influenced by the properties of the crude oil as well as light, temperature, winds, waves, and currents. All of these factors affect the rates of evaporation, dissolution, dispersal and sedimentation processes. Additionally, the nutrient content of the water can affect the rate of microbial degradation. Weathering rates also vary for the various components in a crude oil. The more volatile aromatic fractions tend to evaporate rapidly. Certain fractions, usually the heavier ones, do not weather and these may be deposited in sediments or they may float as tar lumps or tar balls. Oil and its breakdown products may remain in sediments indeterminately until they are churned up by turbulence to recontaminate a recovering area.

The persistence of crude oil in the differing marine environments of the various OCS areas may vary considerably. Most observations of oil spills are for temperate areas, and little is known about the properties of crude oil in the chilled waters of the Alaskan areas. The viscosity of crude oil increases at lower temperatures,and in frigid Arctic waters many crudes may spread very slowly if at all. Microbial degradation will also be slower in Arctic waters because the oil is more viscious,perhaps forming thick films or clumps which are harder for the bacteria to attack. Further, the low temperature slows the metabolism of the attacking bacteria. In addition, limited winter daylight reduces photochemical oxidation of oil spills in the more northern areas. Oil exposed to the very low temperatures of the Arctic winters may sink. Any oil contaminating bottom sediments in the Alaskan areas is expected to be more persistent than oil in the sediments of more temperate areas, such as Southern California.

The conditions which led to the blowout of well A-21 on platform A in the Santa Barbara Channel were discussed in a previous section. This discussion focuses on the biological effects of this massive oil spill. The factual material for this discussion was taken primarily from the excellent discussion of the Santa Barbara oil spill contained in a lengthy comment received from the Southern California Council of Local Governments. This discussion presented here is limited to the environmental impacts of the Santa Barbara oil spill.

It is virtually impossible to assess the total and long-term damage to the Santa Barbara Channel ecosystem which occurred as a result of the spill. One primary reason for this difficulty is the fact that adequate baseline information is not available. This lack of a detailed ecological description for the affected area prior to the oil spill makes it difficult to be certain that the ecosystem has recovered to pre-spill conditions. Nevertheless, at least one scientist noted that the number of marine organisms appeared to be roughly comparable to pre-spill populations and concluded that the spill's effect on marine life was negligible (15).

This controversy about the long-term damage to the marine ecosystem aside, the short-term effects were considerable. Foster (16) estimated the number of organisms killed and the amount of biomass removed as a result of oil pollution and oil cleanup activities.

Habitat and Organisms	
Rocky Intertidal Zone	
Barnacles	8,770,000 killed
Surf grass	16 tons of blades and attached algae and invertebrates removed
Polychaete worms	80,900 killed
Limpets	51,800 killed
High Intertidal Zone	
Crevice fauna (mostly arthropids)	20,000 killed
Mussels	30,000 killed
Sandy Beaches	
Sandy Beach macrofauna	15,000,000 removed during beach cleanup

Deep Subtidal Zone	
Benthid invertebrates	6,000 tons lost
Neritic Habitat	9,000 killed
Marine Birds	(60% loons and grebes)

Marine birds losses are the most dramatic example of the environmental consequences of the Santa Barbara oil spill. Oil coated birds usually die. Even in treatment centers, mortality rates of 90 percent and higher have occurred. Oil coating disrupts the water repellent properties of the feathers, causing the birds to become waterlogged and sink. Also, the insulating properties of the feathers are destroyed by oil coating causing loss of body heat. When the birds attempt to clean their feathers, they ingest oil which can become an additional cause of mortality.

The damage listed by Foster which occurred to other organisms was less dramatic. The organisms in the rocky intertidal zones which were killed by the oil spill died primarily from the smothering effect of the oil. Sand-blasting and steamcleaning of the rocks to remove the oil stains undoubtedly killed many intertidal and splash zone organisms such as periwinkle, limpets, mussels, pill bugs, etc. Approximately 60 percent of the mussels killed in Santa Barbara harbor were killed as a result of steamcleaning.

Sand beach macrofauna, which includes sand hoppers, sand crabs, bloodworms and many additional species, were killed primarily as a result of sand removal during beach cleanup operations. Shallow subtidal organisms, which include giant kelp, other plants, and invertebrates, apparently suffered only minor impacts.

The long term effects of the Santa Barbara oil spill are difficult to estimate and there is some disagreement among scientists. Foster (16) concludes:

> "The continued presence of oil from the initial spill on solid substrata and in sandy beaches, the observed changes in deep subtidal benthic communities, and the fact that oil continues to escape from the platform, all suggest that the Channel has not recovered."

Straughan (15) concluded that the spill's effect on marine life was negligible. With minor exceptions, the area impacted by the Santa Barbara oil spill has for all practical purposes returned to its pre-spill condition.

The fact that the massive Santa Barbara oil spill apparently has not resulted in major long-term impacts on the Santa Barbara Channel ecosystem should not be used to conclude that massive oil spills in other areas under different circumstances will also result in negligible impacts. What the above discussion points out is that perceptions of the Santa Barbara oil spill as a catastrophe which permanently destroyed or altered environmental conditions of the area are not factually valid.

D. NATURAL PHENOMENA AND THEIR IMPACT ON OCS OIL AND GAS DEVELOPMENT ACTIVITIES (2, 10)

OCS oil and gas development operations will at times be subjected to the stress of severe storms, ice, earthquakes, tsuanamis, and unstable bottom conditions. These differences in the natural environmental conditions that can cause impacts on OCS oil and gas operations provide another means of assessing the relative environmental hazards of different OCS areas. The constituent phases of the oil development process to be considered are: exploration, production, storage, and transportation.

1. EXPLORATION PHASE (10)

If during exploratory drilling the drilling unit or platform collapses, capsizes, or moves from the drilling site, the marine riser will fail and small volumes of drilling muds and cuttings will be released into the sea. If the drilling has penetrated oil and gas formations, there is also the possibility of a blowout. If sufficient warning is given, all wells can be closed so that chances of a blowout are substantially reduced.

Severe storms can affect both floating and fixed platforms. Experience to date indicates that industry has had a certain measure of success in scaling up Gulf of Mexico technology to meet the more hostile storms found in the North Sea. Losses have occurred, however. Since 1965, severe weather was either a prime or contributing factor in the loss of 10 drilling rigs. Prudent operation of a rig dictates that drilling operations stop when weather conditions exceed the operational limits specified in the design. Experience with the severe storm environment in the North Sea shows approximately a 14 percent average annual downtime due to bad weather.

Earthquakes affect exploratory drilling in more complex ways. Fixed platforms can be subjected to severe shaking and the stress attendant to these accelerations. Additionally, a number of earthquake related events can disrupt the foundation of the platform. Earthquake hazards to

fixed platforms can probably be mitigated by proper design and careful placement to avoid bottom types prone to ground rupture, differential settlement, landslides, or liquefaction of sediments. Floating drilling rigs are less vulnerable than platforms. They would be only slightly affected by local tsunamis and not at all by earthquakes.

Ice in sufficient quantities can present a significant hazard to almost any offshore structure. The hazards of moving ice packs or the threat of ramming by ice islands represent environmental phenomena beyond the present limits of technology. The truly awesome forces exerted by large ice flows, especially ice islands, which can score 30 foot deep trenches on the seafloor, simply preclude Arctic drilling operations except for about two months in the summer. Thus, ice, which is not viewed as a serious problem in the areas other than the more northern Alaskan areas, represents a technological barrier to offshore drilling in the Arctic. However, recent technical developments may offer a means of enduring ice pressures. General Dynamics has developed a design concept for a moored drilling system that includes a cone-shaped hull that is "squeezed" upwards by ice pressure until the weight of the hull breaks the ice. The system is designed to operate in depths up to 660 feet and fast ice accumulations up to 5 feet. Global Marine has also been developing an ice breaking drill ship which employs a Pneumatically Induced Pitching System (PIPS) to break ice. With new technologies such as these, drilling in Arctic waters may one day become technically feasible.

Federal OCS operating experience has demonstrated that unstable bottom sediments can pose a serious threat to bottom fixed structures. This problem can in most areas be circumvented by careful analysis of bottom sediments as part of the drilling rig and production platform siting process.

2. PRODUCTION PHASE (2,10)

Almost all offshore production systems installed to date are fixed steel frame platforms. An emerging alternative to fixed production platforms is the subsea production system (subsea completions) which involves placing the wellheads on the ocean floor rather than on platforms. As water depth increases, the costs of fixed platforms rapidly increase, and this increasing cost is one reason for developing the subsea completion technology. The increasing cost of production platforms has also lead to an increase in the number of wells that each platform must service. Modern platforms are able to serve 20 to 25 wells. Future platforms can be expected to service 40 or more wells. The more wells there are on a platform, the more serious the consequences of damage to the platform.

Fixed production platforms face the same natural hazards as the fixed platforms used in exploration. Severe storms are not as hazardous as they are disruptive. Production operations taking place on fixed platforms should not be seriously disrupted by the vast majority of severe storms. Further, prudent operating practices dictate shutting down production, closing the wells, and abandonment of the rig during truly severe storms. Of course, advance warning of impending severe storms is necessary and in many of the Alaska OCS areas, expected warning times might be as short as one or two hours. Subsea completions generally avoid the hazards of severe storms.

Earthquakes can and do result in numerous events disruptive of OCS oil and gas production facilities. Among these are: (1) ground vibration; (2) ground rupture; (3) landslides including subaerial and submarine rock slides, avalanches, and mudflows; (4) liquefaction of sediments; (5) differential settlement; and (6) seismic sea waves (tsunamis) and seiches. All of these events occurred as a result of the March 27, 1964, Alaska earthquake in Prince William Sound. The Cook Inlet oil and gas wells evidently were not appreciably damaged. Some damage could have resulted in 1964 if the present extensive development of these fields was present. Still, in view of the intensity of the Prince William Sound quake (Richter 8.3 - 8.6), the lack of damage to the Cook Inlet petroleum fields speaks well for current structural design capabilities in earthquake prone areas.

This is not to say that earthquakes will not damage petroleum fields. Damage is more likely to result where local features or situations develop, such as surface rupture where a fault crosses a well and the well is offset as a result of movement or where subaerial or submarine landslides cut a subsea completion or topple a production platform. Such events can occur as a result of earthquakes of far less intensity than the Prince William Sound quake. Destruction considerably out of proportion to the intensity of the quake can occur in localized areas where fortuitous conditions are present. Therein lies the major concern. However, as industry gains additional experience in coping with seismic events, these hazards should be reduced. For example, a 940 foot steel frame platform has been designed, but not yet installed, for use in the earthquake-prone Santa Barbara Channel area. This platform is designed to withstand the maximum expected ground shaking in the Santa Barbara Channel.

The landslides, liquefaction of sediments, and differential settlement of sediments associated with earthquakes represent additional hazards for OCS development in seismically active areas. Once again, the awesome Prince William Sound earthquake provides examples of the disastrous effects of such events. Persons interested in the details of the findings related to the Prince William Sound quake are referred to the summary presented in

U.S. Geological Survey Professional Paper 546. Avoidance of areas of potentially unstable bottoms is the only known method of preventing accidents caused by these major land movements. Extensive test boring programs must be conducted prior to siting production platforms in seismically active areas. This is particularly important because there is no advance warning of impending earthquakes.

The potentially disastrous effects of tsunamis are not expected to pose a serious hazard to the majority of offshore production platforms or subsea completions. Decreasing water depths and amplication by coastal features are the primary intensifiers of the destruction forces of tsunamis. In water depths greater than 200 feet tsunamis are expected to cause no damage. The postulated wave heights of tsunamis are considerably less than the design wave height of OCS drilling platforms.

Ice related hazards to OCS production arise from four principal sources. First, ice accretion on surface structures increases their weight, freezes equipment, and is a safety hazard. Heating coils and similar devices can mitigate the hazards of ice accretion. Moving pack ice poses more serious hazards in the Alaskan Arctic areas. Offshore production platforms will face many of the same problems as drilling rigs. Modified conventional platforms may be possible, but in general, new technology such as subsea completion systems for deeper water and artificial islands for shallower water will have to be developed before production is practicable in Arctic areas.

Ice islands present a particularly difficult problem for Arctic petroleum development. These islands can be over 200 feet thick and range from a few thousand square feet to a few hundred square miles in size. Drift rates can exceed one mile per day. If a truly large island drifts into a drilling platform or even an artificial island, the petroleum production structure will likely be destroyed. It may be possible to protect OCS structures from drifting ice islands by using large ships to tow these islands away from OCS structures. Subsea completions would avoid this hazard in deep water. However, in shallow water where ice islands ground, scouring of trenches 30 feet deep can occur. Obviously subsea completions and pipelines subjected to such forces would fail.

3. STORAGE PHASE (10)

There are three types of storage devices used for OCS petroleum production. The most common is the familiar cylindrical oil storage tank used onshore. Offshore storage in either floating or submerged vessels is also possible.

The volume stored in all three types of storage devices is very large. Tank sizes are rarely smaller than 200,000 barrels and can be as large as 1,000,000 barrels. Even larger tanks are being proposed.

Onshore, storage tanks can be damaged or destroyed by flooding, by tsunami waves, by earthquake shaking, and by the various forms of soil movement frequently associated with seismic events. Damage from flooding and tsunamis can be prevented by proper site location. The same is true for avoiding damage due to loss of soil stability. The ground vibrations of earthquakes can cause sloshing movements in storage tanks which can intensify into overturning movements and cause buckling of the base ring with subsequent collapse of the structure. This hazard can be reduced by minimizing the free surface within the tank. Even if damage should occur to onshore storage tanks, secondary protection against oil spills is provided by surrounding the tanks with dikes capable of containing the total amount of stored oil. Severe natural phenomena are least likely to affect onshore storage systems.

Both forms of offshore storage can be subjected to the forces of severe events such as storms, tsunamis and moving ice. The principal hazards for floating storage tanks result from the damages inflicted by grounding or capsizing. Breaking mooring lines is the event that sets floating storage tanks adrift. The likelihood of grounding can be reduced by anchoring floating storage tanks in deep water. This same deep water will allow tsunamis to pass without damage. Deep water moorage far from shore also allows more time to recover an adrift storage tank. Capsizing can also be avoided by special design. Storage tanks which are long and thin and float nearly submerged will not likely capsize. The Shell Corporation has built a 300,000 barrel storage tank of this type for use in the North Sea.

Underwater storage tanks are susceptible to damage from severe storms, earthquakes and tsunamis. The passage of large waves during severe storms generates considerable forces. In shallow water, these forces penetrate to the bottom. Surrounding storage tanks with wave attenuation barriers will abate these forces and protect the storage tank. This type of system is being installed at the Ekofisk field in the North Sea.

Underwater storage tanks are particularly vulnerable to earthquakes and tsunamis. The ground vibrations of earthquakes produce large drag and inertial forces on these bulky structures. For more severe earthquakes,

these forces can easily exceed those associated with severe storms. If the underwater storage tank survives the earthquake forces, there are still the tsunamis forces to endure. As the tsunami passes, the mean water level increases thereby increasing the bouyant forces. At depth, the passing tsunami increases drag and inertial forces to levels considerably higher than those associated with severe storms. Each of these facts probably make underwater storage impractical for seismically active areas of the OCS.

Both surface and underwater storage tanks can be impacted by moving ice. Floating storage is obviously more vulnerable but large ice islands can ground submerged storage tanks unless these structures are secured in water depths sufficient to allow even the largest ice islands to pass over freely.

Oil spill containment will be very difficult for both floating and submerged oil storage tanks. The case of spill containment around onshore storage tanks alone would make onshore storage less hazardous. For areas where storage on shore areas is impractical due to large distances to shore, floating storage can be used but such storage will be more hazardous. In general, the hazards of underwater storage would probably rule out this storage method except perhaps for certain Arctic areas where there is a severe ice hazard.

4. TRANSPORTATION PHASE

Transportation of OCS oil and gas production can be separated into two segments. Gathering of the production from adjacent producing areas to concentrate a volume sufficient for economical shipment is the first step. The extent of such gathering systems is directly related to the production rates for the petroleum reservoirs. For highly productive fields, gathering systems are typically not as extensive as those needed in less productive fields. Pipelines are the most common transportation means used in gathering systems in the Gulf of Mexico OCS fields. Barges and small tankers moored adjacent to platforms are an alternative gathering system transportation mode.

Movement of the petroleum out of the OCS field is the second segment of the OCS transportation system. In areas where the OCS production will be consumed in the adjacent shore area, the production gathered from adjacent tracks is moved to shore areas either by pipelines or tankers and tank barges. Where the OCS production is not consumed in the adjacent coastal areas, it must be exported. As discussed above, storage of OCS petroleum production prior to transshipment can be either onshore or at sea. If on shore storage

is used, the transportation system is subjected first to the hazards associated with the mode of movement to shore. Then, there are the hazards of storage and finally the hazards of the export transportation system. In areas where at sea storage is practical, single point moorings can be used to load tankers for transshipment. In general, this system should be less hazardous than moving the production to shore storage areas and loading tankers in coastal areas. Most of the petroleum production of the Alaskan OCS areas will be exported for consumption in other areas. This fact alone is sufficient to make Alaskan OCS petroleum production more hazardous than OCS areas where the petroleum production is consumed in the adjacent areas.

a. Pipelines

Historically, pipelines have been the safest means of bulk transportation. This is expected to continue in the frontier areas of the OCS. Pipelines are, however, subject to damage from natural phenomena. Elaborate route selection and engineering studies coupled with seismic and test boring programs could minimize the likelihood of having the pipeline traverse areas of unknown soil properties. Where pipelines traverse fault zones or other regions of poor soil stability, installation of check block and pressure relief valves on both sides of the hazardous areas would help to minimize spillage if the pipeline should break. The required burial of pipelines in water depths less than 200 feet should provide protection against anchor dragging which has been the cause of most major pipeline breaks.

In the Arctic and subarctic areas of Alaska, pipelines will be exposed to the additional hazards of ice and permafrost. The forces ice can exert are substantially greater than those a pipeline can endure. Therefore, pipelines will have to be constructed and placed in ways that will avoid exposure to ice. This requirement can pose some formidable problems. As already noted, ice islands can scour the sea bottom to depths of 30 feet. Similar hazards are encountered at shoreline. The accumulation and movement of ice along the shore in the fall and spring could subject the pipeline to crushing loads of folded ice in the fall and tearing and shearing forces during the spring breakup.

Permafrost must be completely avoided, completely eliminated, or completely preserved in all phases of OCS petroleum production. Little is known regarding the presence and extent of permafrost under the oceans. However, where it exists under the oceans it should pose the same problem it does to pipelines on shore. The heat of the pipeline causes melting. The melted

permafrost may have considerable potential for solifluction or downslope movement. Additionally, where freezing occurs over a deeply buried pipeline (assuming deep burial is adopted to avoid ice hazards), the melted permafrost around the pipeline will be an incompetent layer sandwiched between two frozen and rigid layers. The rigid surface layer is then subject to heaving, cracking and rupture especially during earthquakes. Building the Trans-Alaska Pipeline has given industry some experience in permafrost problems; and, as a result, pipeline placement in areas of permafrost is less hazardous today than it was, say, five years ago.

b. Tankers

Tankers constitute one of the most serious oil spill hazards of any OCS operation. Historical data indicate that the majority of tanker oil spills resulted from groundings, collisions, and structural failure. Natural phenomena such as severe storms, high winds, or fog often contributed to past tanker accidents. However, in virtually every case, the accident could have been avoided by proper maintenance of the vessel and/or use of prudent seamanship either to avoid severe storms or to modify course or speed and thereby minimize wave forces while trapped in bad weather. Even with proper maintenance and use of prudent seamanship, tanker operations will be hazardous in the more arduous frontier OCS environments.

Tsunamis pose a serious threat of major oil spillage whenever tankers moor at fixed berths in tsunami-prone areas. Moored at a fixed berth, the tanker is in shallow water where tsunamis develop their most destructive forces. Mooring lines part, and the vessel is at the mercy of the waves and currents until the engines generate sufficient thrust to regain steerage. During the Prince William Sound earthquakes, the tanker ALASKA STANDARD, moored at Seward, was carried several hundred yards out into the harbor. In Valdez, a freighter was not so lucky. The mooring lines on the CHENA parted when the land at shoreline slumped. The freighter was first sucked away from the pier by the outrushing water (during tsunamis the water first rushes outward before the tsunami wave) and was then thrown onto the mud flats by the reflected wave. Similar occurrences have been observed wherever ships have been moored when a major tsunami hit.

The hazards of tsunamis in harbors can in many cases be avoided by use of single-point moor oil transfer facilities placed in deep water and away from the shoreline. In deep water, tsunami wave forces are negligible. In the event the moor parts, which is far more likely during severe weather than passage of a tsunami, the ship will have maneuvering room to regain control.

Ice, as previously mentioned, is a major hazard in the more northernly OCS, particularly in the Alaskan Arctic and subarctic areas. Three types of ice exist in the northern seas. (1) Icebergs or ice islands which are drifting remnants of ice broken off from continental ice masses. In the Arctic, ice islands are a major hazard. (2) Winter ice which forms each year occurs in the many openings scattered throughout the polar ice pack as well as in the open water of the adjacent seas. In the warmer, more southern areas of Alaska, winter ice forms principally along the shore. In the Arctic, winter ice also forms as the Arctic Ocean freezes to an average depth of 6 to 8 feet. Along the shore, winter ice can be piled by the tides into ridges over 40 feet thick. Strong winds and currents as well as the spring thaw break off fragments of the winter ice, forming winter drift ice. (3) Ice that forms over several years is known as polar ice. The thickness of polar ice in the Arctic is normally 10 to 13 feet by the end of winter, decreasing to about 6 to 10 feet in the summer. Strong winds often push large polar ice flows in shore through areas of thin seasonal ice causing the winter ice to break and pile up into larger pressure ridges. These ridges can be over 40 feet high with keels over 120 feet deep. These keels frequently ground and scour the bottom.

Tankers are very vulnerable to ice. Even drift ice can make normal tanker operations hazardous. However, the Manhattan experiment demonstrates that it may be possible to design ice-stregthened merchant ships which are capable of Arctic operations during summer months. Even the largest icebreakers built to date are not capable of operating north of the Arctic Circle during the winter and spring. Perhaps submarine tankers can be designed to operate under the polar ice much as the atomic submarine Nautilus did in 1958. Studies have indicated that transportation of Arctic oil in submarine tankers is feasible using the Northwest Passage to Greenland.

E. ENVIRONMENTAL IMPACTS OF VARIOUS DISCHARGES

Various OCS oil and gas development discharges can cause adverse impacts upon the marine environment. The most severe impacts that can affect organisms and communities are those that result from discharged oil. Oil discharges can be classified as having two causes: (1) accidental discharges caused by well blowouts, pipeline ruptures, and other unintentional occurrences; and, (2) operational discharges. The more familiar of the two causes, accidental spills, range in size from a few barrels to over a hundred thousand barrels. Operational discharges, those that occur during routine operations such as formation water discharge and separator fluid discharge, may result in environmental stress of large magnitude that is known as chronic low-level pollution (10).

Evaluating the precise environmental impacts of oil on the marine environment is difficult. The National Academy of Sciences has noted the following (4):

> "Measuring the effects of oil on marine life is difficult. Each experimental study must include an adequate number of controls whereby single variables are evaluated through interdisciplinary approaches so that the effects of different biological parameters can be resolved. Many earlier studies of the effects of oil cannot be adequately evaluated because (1) the experimental work was not properly designed (for example, lack of adequate replication) and (2) the oil concentrations and other variables that affect marine life are inadequately monitored. Well-designed laboratory studies are essential in determining the precise effects of oils on selected marine organisms. Studies are needed to measure the range of oil concentration in chronic and spill-type situations. Laboratory studies are also needed to compare organisms. However, evaluations of effects must be made under adequately monitored field conditions."

1. BEHAVIOR OF OIL IN THE MARINE ENVIRONMENT (2, 6, 10)

Crude petroleum is a mixture of hundreds of hydrocarbon compounds derived from biological matter that has accumulated in reservoirs and has been subjected to physical, chemical, and biological processes for millions of years. The physical-chemical composition of petroleum varies greatly, depending upon where it is obtained. Toxicity of each type of oil depends substantially on the water soluble and aromatic fractions of petroleum that it contains. The volatile aromatics are considered the most toxic, although other low boiling hydrocarbons may also be toxic.

Petroleum derivatives, the distillate fractions of crude oil - gas, gasoline, kerosene, light gas oil, heavy gas oil, and light lubricating oil, and blends of diesel fuel can also be toxic. Some distillates, such as No. 2 fuel oil and other petroleum derivatives, appear more toxic than crude oil becuase distillates contain higher proportions of medium boiling aromatics which have lower volatility and persist longer in the environment than other fractions.

Persistence, or residence time, is the time that oil is detectable in the water, sediments, or biota. However, criteria and techniques for determining or estimating residence time very considerably among investigators, and reported persistence can depend as much on the sensitivity of detection methods as upon how long the oil in fact remains. Visual observation, the least sensitive, is employed most frequently. Although some studies are based on chemical analyses and bioassays, lack of uniform observation and

detection methods confuses the question of oil persistence. Although visual observations can provide useful data, until methods are standardized, these gross data would be interpreted as underestimating oil persistence.

Petroleum in sea water is altered chemically by evaporation, dissolution, microbial action, chemical oxidation, and photochemical reactions - often collectively - and is called weathering. How fast oil degrades is markedly influenced by light, temperature, nutrients and inorganic substances, winds, tides, currents and waves. They all affect the microbial degradation, evaporation, dissolution, dispersal, and sedimentation processes. Degradation rates appear to vary with the composition of the oil. The more toxic fractions are generally less susceptible to microbial degradation. The heavy residuals that do not degrade may be deposited in sediments or they may float as tar lumps or tar balls. For a detailed analysis of the harmful effects of oil upon marine organisms, see Appendix A.

a. Physical and Chemical Changes (6)

Because the varying constituents of oil are affected at different rates by "weathering" processes, the relative composition and, therefore, the biological effects of spilled oil also vary.

Evaporation depletes the more volatile components (fractions 1, 3 and 5) but causes little separation (fractionation) between hydrocarbons that have the same boiling points but substantially different structures and effects on organisms. Hydrocarbons lost through evaporation go into the atmosphere.

Dissolution also removes preferentially the lower molecular weight components from an oil slick. Some potentially toxic fractions, such as the aromatic hydrocarbons, have a higher solubility than other less toxic compounds, e.g., paraffins of the same boiling point. Once dissolved in seawater, these soluble constituents may follow quite different pathways than the more conspicuous slick.

Biochemical (microbial) attack affects compounds within a much wider boiling range than evaporation and dissolution. Hydrocarbons with the same general structures are attacked at roughly the same rates. Normally, paraffins are most readily degraded. Continued biochemical degradation causes gradual removal of the branched alkanes. Cycloalkanes and aromatic hydrocarbons (fractions 3-8) are more resistant and disappear at much slower rate.

Chemical degradation processes of oil during weathering are not well understood. Oxidation affects most readily aromatic hydrocarbons of intermediate and higher molecular weight.

The effect of these weathering processes is the rapid (within 48-96 hours) depletion of lower boiling fractions (boiling point 250^{o}C) from a spilled slick by evaporation and dissolution and the slow degradation (terms of years) of higher boiling fractions by microbial and chemical oxidation.

Oil incorporated into marine sediments apparently does not undergo the same changes as those observed in oils exposed to the atmosphere. Also, the absence of an abundance of dissolved oxygen in most marine sediments and the shielding from sunlight cause the oil to retain its original composition for much longer periods.

Thus, oil originally incorporated in sediment may be later released to the environment (by the actions of waves, tidal current, or dredging) little altered from its original composition. After release, the oil can be moved into other areas where it can cause deleterious effects. Furthermore, the oil released from sediments may contain pesticides (or their decomposition products) which were originally associated with mineral grains incorporated in the deposits.

b. Emulsion Formation (6)

Oil when mixed with seawater tends to form emulsions. Depending on the chemical composition of the oil and presence or absence of other surface active constituents (surfactants), the emulsions may be either oil-in-water (as in milk) or water-in-oil (as in butter). Emulsion formation changes the physical characteristics of the oil and its physical and chemical behavior in the ocean and, therefore, alters its effects on marine organisms.

Many oils when vigorously mixed with seawater from oil-in-water emulsions. The fine oil droplets are then dispersed through a large volume of water, often disappearing from the ocean surface. In a stable dispersed form, the oil does not "wet" surfaces and also provides maximum surface area for microbila and chemical degradation of the oil. The large surface area also permits soluble constituents in the oil to dissolve more readily in seawater.

c. Movement of Oil Slicks (17)

A volume of oil suddenly dropped on the sea surface is free to spread horizontally. The oil spreads at three different rates, depending on when one looks at the spill. Each rate is determined by a balance of various properties of oil and water. The first two spreading rates involve balances between the buoyancy - induced spreading force and initially the oil's inertia, then later the water's viscous drag. It is convenient, therefore, to distinguish

three different phases in the spreading of a spill: an inertia phase; a viscous phase; and finally a surface-tension phase. The duration of each phase depends on the amount of oil initially released. It is commonly observed that oil slicks cease to spread after some time. Various theories have been developed to explain this phenomenon. One of the more successful theories assumes that the hydrocarbons responsible for the observed surface tension are lost through either evaporation into the air or dissolution into the water. (18)

In addition to the well documented spreading phenomena, an oil spill exhibits two other important properties. At some time during the spreading process, variations in the wind, waves, and current usually separate a large spill into several large patches surrounded by many smaller patches. The large patches tend to move apart with time. This increases the width of the path swept by the spill and also increases the rate of dissolution of hydrocarbons into the water. Furthermore, waves on the open ocean or the surf near shore mix a portion of the oil into the seawater. The tiny oil droplets suspended in the water substantially increase the surface area available for dissolving hydrocarbons into the water. Water-in-oil emulsions may also be formed.

The suspension of oil droplets in seawater is related to the turbulence in surface waters. Turbulence is increased when waves break so that winds strong enough to cause whitecaps substantially increase the turbulence of surface waters. The depth to which this wave induced turbulence penetrates varies, but 30 to 100 feet might be a representative range for the depth of penetration of the strong wave generated surface turbulence. Thus, the fine oil droplets dispersed by wind mixing would be most abundant in near surface waters (less than 100 feet). Mixing of waters caused by strong tidal currents in estuaries can mix oil droplets to much greater depths.

Oil droplets respond to turbulence depending on their size; the rise velocity of a small oil droplet will be much less than the rise velocity of a large droplet. Thus, one can expect to find small oil droplets fairly deep, while large droplets should remain near the surface. Increased mixing also increases the depth of droplet penetration into the water.

Wind blowing over the water surface imparts momentum to the water and sets the water in motion. At the very surface water layer movement is in the direction of the surface wind. It will continue to move in that direction so long as the wind continues to blow. The motion while the wind blows is of importance, because the surface layer of water and associated oil slicks can move substantial distances.

d. Movement of Oil Slicks in Estuaries (17, 19)

In an estuary, movements of oil slicks are complicated by oscillatory tidal currents. Therefore, a slick in an estuary will behave somewhat differently than it would in the open ocean where tidal currents have relatively little effect.

In the surface layers, the spilled oil will be extended into an elongated horizontal plume by tidal currents. Through the action of mixing processes previously described, these will develop a widespread slick of relatively low concentration, on which is superimposed, with each tide, a relatively narrow plume of higher concentration.

Tidal currents moving past irregularities in the shoreline further disperse the oil. Intense mixing of oil and surface waters can occur where strong tidal currents move slicks across an irregular bottom such as the sills (submerged ridges) in fjord-like estuaries.

Frequently, eddies associated with embayments or with points of land that project into the estuary will temporarily trap water containing high concentrations of oil as the plume is carried past by tidal currents. Most of the oil is carried out on past the shore feature by the tidal current, while the trapped oil slowly spreads out into the main stream causing dispersal behind the main body of the slick. When the tide reverses, the process is repeated, with a resulting dispersion on the opposite side of the slick.

e. Transfer of Oil Films to the Atmosphere (20)

Observations of the elimination of oil films from large lakes suggest other important processes may be actively removing oil from sea surface and injecting it into the atmosphere to be carried away by the winds.

Recreation spawned oil films are eliminated from the water surface in 70 to 90 hours after boating activity has stopped. There was no evidence that these oils are removed by evaporation or either dissolution or emulsification in the water, the major processes previously discussed. Instead it appears that most of the removal occurs by formation of tiny droplets (aerosols) which are injected into the atmosphere. Furthermore, the droplets carried in the atmosphere preferentially absorbed salts and certain polar organic materials from the water. In other words, the chemical composition of the bulk water does not provide a reliable indicator of the chemical composition of these airborne droplets.

The combined action of bubbles and ultraviolet irradiation was found in laboratory experiments to be most effective in removing oily films from the water surface. Exposure to the atmosphere and ultraviolet radiation apparently oxidized the hydrocarbons in these natural films. The film materials preferentially pick-up other oil-soluble constituents in the water.

Surfaces of droplets are also likely to be colonized by bacteria and other micro-organisms. While conclusive data are still lacking, these processes may be the cause of reported rapid disappearance of oil slicks in many marine areas.

f. Behavior of Spilled Oil on Shore

When an oil slick reaches the shore, its behavior depends on the nature of the oil, its emulsions, and the shore. Usually, much of the oil will be carried to the beach and deposited at the high-water mark by successive tides. Well-weathered or heavy oils mix with sand or plant debris during this process, forming "oil-cakes." These cakes may cause greater trouble by sinking into sand and gravel or clinging to seaweeds.

Pebble beaches are more troublesome to clean than sand beaches because of the oil may sink among the pebbles to a depth of 0.5 -1 meter. Oil does not sink so readily into wet sand. Breakers may, however, throw fresh sand over the oil containing sand, burying it. In this way a beach may appear clean shortly after an oil slick has come ashore. Later removal of surface layers during storms or in seasonal sand movements exposes the oil.

Oil may also persist on dry rock surfaces or among weeds, barnacles, and mussels, where in addition to the biological processes it is slowly removed by drying, hardening, and the incorporation of sand particles, finally eroding or flaking off. Although some oils fail to wet the mucous body surfaces of animals or the mucilaginous surface of certain algae, they cling to the byssus-threads of mussels and the outer layer of shells and certain upper shore weeds which have a naturally oily surface. Oil also has an affinity for some marine grasses and flowering plants.

2. BIOLOGICAL EFFECTS OF SPILLED OIL AND RELATED OCS DEVELOPMENT ACTIVITIES (2, 10)

Exposure to spilled oil can affect an organism physiologically and behaviorally. Many of these effects are cellular. How oil affects individual organisms may be generalized as: direct lethal toxicity; sublethal disruption of physiological

processes and behavior; effects of direct coating by oil; incorporation of hydrocarbons, causing tainting and/or accumulation of hydrocarbons (including carcinogens) in organisms directly or by food-web transfer; and changes in biological habitats.

Lethal toxicity (death) can occur when hydrocarbons interfere directly with cellular and subcellular processes, especially membrane activities. Sublethal effects may also involve cellular and physiological effects. Although they do not produce immediate death, sublethal responses ultimately can affect survival of individual organisms, their local population dynamics, and the dynamic equilibria of biotic communities*. Important in this category are disrupted behavior, higher susceptibility to disease, reduced photosynthesis, reduced fertility, and abnormal development.

Coating is generally associated with the high-boiling fractions of oil, i.e., weathered oil. It can be a problem for intertidal sessile species, plankton, and diving birds. Mobile organisms would seem to have the capacity to avoid prolonged exposure. Subtidal benthic species are somewhat protected from coating because oil does not occur as a film on subtidal substrate** except in the worst local spill situations. Coating smothers or mechanically interferes with movement and feeding or causes loss of feathers, loss of heat, salt balance problems, etc.

The incorporation of hydrocarbons, including carcinogens, is of particular concern because they can accumulate in marine organisms and be transferred to other organisms through the food web. Both tainting and accumulation of hydrocarbons can occur in marine organisms exposed to oil. Oil entering a salt marsh, for example, is found in virtually all marine organisms. Once exposure is terminated, however, with time some species have recovered completely.

Significant shifts in composition and distribution of species in a region result when a habitat is so changed as to become unsuitable or less suitable to a species which normally inhabit it. Intertidal and subtidal benthic species are, therefore, important subjects. How much and what kinds of oil

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*A population is here defined as a group of individuals of the same species inhabiting the same geographic region of the marine environment. A community is here defined as a group of populations occupying the same regions or biotic zone in a region.

**A substrate is the material or surface from which a plant or animal obtains support.

prevent species from utilizing a substrate, for example, is largely unknown; but in view of available data, the presence of low to medium boiling point aromatic hydrocarbons at concentrations as low as 10 to 100 parts per billion may chemically perturb many species. The effects of higher boiling, insoluble materials depend on how much an organism relies on its particular substrate and how much it is altered by oil. Species depending on a substrate only for passive support may be little affected by habitat changes caused by the oil. But those living in the substrate or otherwise actively depending on the substrate are surely more vulnerable. Still other effects are acclimation and selection, processes that may alter how individuals and populations tolerate concentrations of oil. Table IIIE-1 lists the sensitivities of selected species to oil.

Table IIIE-2 is an assessment of toxic sensitivities; only two categories of marine organisms - adult and larval stages are considered. Available data indicate that death may be expected in most adult marine organisms from exposure to 1 to 100 parts per million of total soluble aromatic hydrocarbon derivatives (SAD) within a few hours exposure. For larvae, lethal concentration may be as low as 0.1 parts per million of SAD. These lethal concentrations can result from unweathered oil slicks. SAD concentrations of 10 to 100 parts per billion may interfere with chemical sensing and communications on which lobsters and anadromous fish depend.

The impacts of oil on local populations may be examined by considering parameters such as population size and age distribution. In looking at impacts, one must remember that accidental spills and chronic discharges are not the same. For accidental spills three general stages may be analyzed: prespill equilibrium, immediate postspill impact, and recovery to equilibrium conditions. In contrast, a continuous discharge results in oil contamination at low concentrations, which may not produce immediate, dramatic impacts but may instead show subtle, long term effects.

Biological impacts are determined by the following factors:

- Type of oil spilled, in particular, the concentration of lower-boiling aromatic hydrocarbons
- Amount of oil
- Physiography of the spill area
- Weather conditions at the time
- Biota in the area
- Season of the year

Table IIIE-1

Effects of Oil on Selected Species[1]

Species	Common name	Lethal	Sublethal	Coating	Uptake and tainting	Habitat change
Birds						
Rissa tridactyla	Kittiwake			X		
Fishes						
Alosa spp.	Alewife	X				
Clupea harengus	Herring	X				
Fundulus heteroclitus	Mummichog	X				
Gadus morhua	Atlantic cod	X				
Micropogon undulatus	Croaker		X			
Morona saxatilis	Striped bass		X			
Pseudopleuronectes americanus	Winter flounder	X	X			
Crustaceans						
Acartia spp.	Zooplankter	X				
Ampelisca vadorum	Amphipod	X				X
Balanus balanoides	Acorn barnacle	X				
Calanus spp.	Zooplankter	X			X	
Crangon spp.	Shrimp	X				
Emerita spp.	Mole crab	X				
Homarus americanus	American lobster	X	X			
Paqurus longicarpus	Hermit crab	X			X	
Pandalus spp.	Shrimp	X				
Mollusks						
Asquipecten spp.	Scallop		X		X	
Crassostrea spp.	Virginia oyster	X	X		X	
Donax spp.	Coquina clam	X				
Mercenaria mercenaria	Northern quahog	X				
Modiolus spp.	Horse mussel		X		X	
Mya arenia	Soft-shell clam	X			X	X
Mytilus edulis	Edible mussel	X	X	X	X	
Littorina littorea and spp.	Periwinkle	X	X	X		
Nassarius obsoletus	Common mud snail		X			
Thais lapillus	Dog whelk	X	X			
Worms						
Arenicola marina	Lugworm	X	X			X
Nereis virens	Clam worm	X				
Stroblosoio benedicti	Polychaete	X				
Other animals						
Asterias vulgaris	Starfish				X	
Strongylocentratus drobachiensis	Sea urchin	X			X	
Plants						
Juncus gerardi	Marsh rushes	X				
Spartina alterniflora	March grasses	X				X
Spartina patens	Cord grass	X				
Laminaria spp.	Kelp	X				

[1] Does not list all species for which data have been reported. Rather, an X represents reported data for those species which were selected for special consideration. An X indicates that some data, regardless of number, have been reported.

Source: The Massachusetts Institute of Technology Department of Civil Engineering, 1974, "Atlantic/Alaskan OCS Petroleum Study: Primary Biological Effects," prepared for the Council on Environmental Quality under contract No. EQC330.

TABLE E-2

ESTIMATED ACUTE TOXICITY SENSITIVITY
(Parts per million)

Class	Estimated concentration of soluble aromatics causing toxicity
Plants	10-100
Finfish	5-50
Larvae (all species)	0.1-1
Pelagic crustaceans	1-10
Gastropods (snails, etc.)	10-100
Bivalves (oysters, clams, etc.)	5-50
Benthic crustaceans (lobsters, crabs, etc.)	1-10
Other benthic invertebrates	1-10

Source: The Massachusetts Institute of Technology Department of Civil Engineering, 1973, "A Preliminary Assessment of the Environmental Vulnerability of Machias Bay, Maine to Oil Supertankers", prepared for the Council on Environmental Quality (NTIS Accession No. COM 73-10564).

. Previous exposure of the area to oil

. Exposure to other pollutants

. Method of treatment of the spill

The potential impacts of offshore oil and gas operations, in particular those of oil spills, are summarized here.

a. Impacts on Plankton (10)

Planktonic organisms comprise a wide range of life styles, from the phytoplankton (plants) to the zooplankton (permanent zooplankters such as larval forms of benthonic organisms). Phytoplankton are generally adversely affected by crude oils and refined products. Laboratory studies have shown that death and growth rate inhibition can occur in crude oil concentrations of 0.001 to 1,000 ppm; other studies have found enhancement of photosynthesis at concentrations below 10 to 30 ppb. Thus, the possibility of both stimulation and suppression of photosynthesis in areas of chronic oil spillage must be recognized. In general, though, the effects are deleterious at the organismic level, but field measurements (e.g., Santa Barbara) of community primary productivity have generally been inconclusive. Primary production is inhibited under an oil spill, which naturally blocks out light to various degrees. Another widely recognized impact on phytoplankton arises from heavy metal loadings, which generally are toxic, but have also been conjectured as possibly triggering red tide outbreaks.

Knowing the low level of oil concentrations that can affect phytoplankton, it is conceivable that the most serious impact comes from chronic low-level pollution. Continuous low level stress could seriously impair phytoplankton growth at both the organism and population levels. This could lead to serious losses in primary productivity, the basic food production and oxygen formation process of these plants. Primary productivity is generally higher over the continental shelf than over deeper waters, as nutrients can cycle more easily.

Effects on phytoplankton will be of the same general magnitude for the same level of development wherever they occur, although species composition will vary. The exception to this is the possibility that more serious effects will be felt by the phytoplankton in colder climates. Here, where oil does not chemically weather as rapidly and microbial degradation is slower, spilled oil remains longer and thus could impact for a longer period. Toxic, water soluble aromatics would have a longer time to dissolve in the water. The

additional problem of oil spilled under ice is an unknown phenomenon; if volatiles cannot escape, they will tend to dissolve in the water to a greater degree, possibly affecting the phytoplankton that live near the ice water interface.

Most of the data concerning impacts on the permanent zooplankton (holoplankton) is related to copepods (small crustaceans). Several species suffer high mortality after several days exposure to oil in a concentration of 1 microliter/ liter of seawater. Longer exposure or higher concentrations (up to 1 ml/l) increase mortality. No information has been found concerning transfer of pollutants from phytoplankton to herbivories. Shading may also disrupt vertical migration of zooplankton, which is lightcued. Both phytoplankton and zooplankton will also be affected on a small scale because of the turbidity attendant to drilling operations, as well as by the discharge of high salinity, low oxygen formation waters.

Of particular interest are the planktonic larvae of various benthic invertebrates and fish. Many of these species are either actually or potentially harvestable, and impacts on the larvae affect population sizes and distributions. These meroplankters (planktonic for part of their life cycle) are generally considered to be very sensitive to environmental stress and predation while in the water column. Although they are not as sensitive as holoplankters; they are, however, more sensitive than the benthic adult forms. The meroplankters are subject to the same types of impacts as other planktonic organisms; lab studies indicate that death and abnormal growth can be expected in concentrations ranging from 10-100 microliters of oil per liter of seawater.

Fish larvae, such as cod and herring, are susceptible to crude oils. In addition, many species of fish have eggs which float in the water column or at the surface; the eggs of several species have sustained high mortailities in some of the more noted spills.

Many of these impacts are localized and of short duration; however, there are longer term possibilities that must be mentioned because they have been postulated by scientists but not definitively proven. Many of the organisms with high turnover rates (short lives, high reproductive potential) are probably not significantly affected by noxious substances. For the longer lived creatures, other effects may be noted. One is the possibility of food chain magnification of trace toxics. The widely known example of this phenomenon is food chain magnification of DDT. Noxious substances may be concentrated because of selective absorption of materials in specific

tissues that are digested by higher trophic level organisms. The possibility then exists of non-toxic levels becoming toxic by this concentrating mechanism. Transfer of these substances through food chains probably occurs; magnification may not.

Lethal and sublethal effects reduce population levels and potential distribution at least in the short term. Long term reductions of primary and secondary productivity of marine ecosystems may result, but there is no data to support this hypothesis. Of particular concern are the effects on age-classes, and the percentage of eggs that reach adulthood is generally quite small. A particular year-class of eggs or larvae may be small due to low fecundity and high predation. The additional stress of a massive oil spill may reduce a year-class to critically low levels.

Like the phytoplankton, the zooplankton will be affected to approximately the same degrees in all areas, given the same level of oil and gas development. The cold versus warm argument applies here also. In areas of heavy commercial fishing, such as the North Atlantic, Gulf of Mexico, Gulf of Alaska, and Bering Sea, eggs, larvae, and juveniles of important fisheries could be affected to a great degree.

b. Impacts on Fish (10)

Little is known about the effects of oil and gas operations on fish at sea. Midwater migratory fish presumably would avoid areas which they sensed were noxious or locally adverse, although some fish might not be able to avoid spilled oil and would suffer from clogged gills and damaged gill tissue. However, tainting of fish is a well-documented occurrence which apparently means that fish cannot always detect noxious conditions. Tainting usually results in a loss to commercial fishermen who cannot sell their catch. Much of the research on the effects on fisheries attempts to analyze declines and rises in catch and catch per effort. In the Gulf of Mexico, where oil and gas operations have been occurring for 25 years, no significant long-term changes in fish catch have been noted. However, the record catches of 1954 have never been exceeded, and recent studies at Texas A&M University indicate that the fish catch has remained high due to increased effort. Shrimp catches in the last few years have been declining both in total catch and catch per effort. No explanation has been offered for these occurrences.

Several physiological - behavioral effects may take place. Oil may affect fish nutrition by blocking taste receptors and mimicking natural chemical messengers which attract predators to prey. Chemical "static" may affect the migratory patterns of fish, an important point to such chemosensing

migrants as salmon, which may be prevented from finding their spawning stream. It has also been suggested that hydrocarbons may block reception of chemicals necessary for reproductive attraction; social conflict behavior may also result. Oil spills might block the estuarine passage of anadromous fish, thus effectively preventing spawning. Direct mortality with severe consequences could occur if a massive oil spill reached nursery areas at certain times of the year.

Demersal fish, especially those with eggs and larvae that remain close to the bottom, should suffer less impacts than the midwater fish. However, entrainment of heavy hydrocarbons and trace metals in sediments is a constantly occurring fate. These entrained substances may enter sea bottom food chains and adversely effect organisms. Bottom organisms may also be affected by turbidity of drilling and pipelaying operations; pipe trenching may resuspend toxic materials that had been entrained.

Much of the toxicity work on fish has been conducted in the laboratory. Many species die in response to applications of crude oil, refined products, trace metals, and drilling mud components in concentrations as well as exposure times that could conceivably be encountered in the ocean.

The significant fishery resources (finfish) of North America are found in the North and Middle Atlantic, central Gulf of Mexico, Gulf of Alaska, and Bering Sea. Some impacts on these resources must be expected, although magnitude estimation would be speculative.

c. Impacts on Benthic Marine Life (10)

Environmental impacts which may be expected to affect benthic marine life adversely will likely result from the discharge of drill cuttings and drilling muds, accidental and chronic discharge of oil and other toxic materials, and pipeline burial. Heavy mortalities were noted at the West Falmouth spill of No. 2 fuel oil, but resettlement eventually took place to some degree within two years. Nearshore benthos are most susceptible to mortality from oil spills.

Drill cuttings can affect benthic organisms in a number of ways. Many organisms are smothered and crushed outright, since they can't move very well. See Section IIIE-3. Other organisms are able to migrate up through the deposit, and some colonize very rapidly. The nature of the cuttings (consistency and composition) may aid or preclude recolonization, however. Attached plants are also exposed to smothering and crushing.

Drilling muds and fine sediment are discharged overboard during drilling operations. See Section IIIE-3. This generally creates a plume of fine sediment and mud materials that flows with the prevailing current. The plume may reach to the bottom and deposition would occur. This creates the hazard of clogging of the filter-feeding mechanisms which abound in the benthic community. Respiratory mechanisms are also affected by sediment plumes. Sedimentation is inimical to viable coral reef development and has been mitigated against where threats to coral reefs exist. Toxic materials are found in drilling muds, including barium (as barium sulfate, the dominant component of drilling muds) which has generally been considered a small hazard because of operator recovery and its low dissociation in sea water.

Most, if not all, benthic biota are either destroyed by the jetting of pipeline trenches or raised into the water column and exposed to predation. See Section IIIE-4. Although recolonization could begin immediately, the native biota could not be fully restored until seasonal reproductive cycles had been completed. Turbidity associated with trenching affects filter-feeders and respiration. Resuspension of toxic heavy metals and pesticides will adversely affect local populations.

d. Impacts on Birds (10)

In the past, the injuries and deaths of thousands of seabirds, shorebirds, and waterfowl have been the most obvious impacts of massive oil spills. It has been stated that the only organisms damaged directly by oil pollution on a sufficient scale to seriously affect populations are seabirds. A large number of oceanic and shorebirds die as a result of the oil pollution, and chronic pollution probably kills more every year than die after a single catastrophic oil spill. It has been estimated that total annual losses due to oil pollution in the North Sea and North Atlantic alone (excluding specific disasters) range from 150,000 to 450,000 seabirds.

At least five factors contribute to the precarious status (extreme vulnerability to catastrophic oil spills) of bird populations.

1. Bird kills result from coating of the feathers by the weathered or unweathered petroleum, destroying their insulating property. Diving birds show no awareness of oil slicks and dive directly into them. Any shorebirds moving about along the shoreline could be covered with washed up oil.

2. Bird populations are small and, therefore, have a high risk of extinction. This means that after the original population (pre-spill) is reduced, natural population fluctuations - easily absorbed in the original stock - could lead to extinction.

3. Bird fecundity - typically two to three young per breeding pair per year - severely limits ability to recoup losses.

4. Maturation usually requires 3-4 years, further delaying recovery.

5. Birds are often highly aggregated, thus exposing the entire breeding population to localized oil slicks.

Significant bird populations exist in most coastal areas, at least for part of the year. Many are migrants, and many are threatened or endangered. Large and diverse bird populations may be found in the marshes and bay areas of the East and Gulf Coasts, as well as in marshes and other wild areas of the Gulf of Alaska and the Bering Sea, especially Bristol Bay. Endangered species may be nearly extinguished if certain circumstances such as a massive spill near a breeding area should occur. Adequate buffer zones and rapidly deployable cleanup equipment could mitigate to some degree these disastrous impacts. Identification of critical habitats is the first step toward such mitigation.

e. Impacts on Mammals (10)

The impacts of oil pollution on mammals are poorly known, although generally recognized to be less serious than on birds. In the rather closely studied Santa Barbara spill, marine mammal deaths due to oil could not be distinguished from mortality due to natural caused. Mammals can be affected by oil, however. The fur-bearers could be affected like birds, i.e., their insulating capabilities are destroyed. Massive spills could suffocate mammals, and ingestion of oil could result in death by poisoning. Marine mammals may be intelligent enough to avoid adverse conditions, but the avoidance itself may disrupt the herd or the migration pattern. Coating of the sea-land interface could effectively remove breeding and hauling grounds from use, a potentially catastrophic occurrence for some species.

Most of the significant mammal populations are on the West Coast and in Alaska, although porpoises of various species are rather ubiquitous.

f. Impacts on Plants (10)

Various types of plant communities could be affected by the different operational discharges and mechanics. The obvious food and oxygen production of plants cannot be overlooked. The phytoplankton community has already been discussed. Benthic algae, seagrasses, kelp beds, nearshore marshgrasses, mangroves, and seaweeds are all communities that could be seriously damaged by: oil spills, chronic oil discharge, drilling mud and cuttings discharges, pipeline laying and access canal construction, and onshore facilities. Large scale impacts on the plant communities, which, while not expected, must be recognized for their potential impacts on the entire food chain.

g. Impacts on Unique and Highly Valued Areas (10)

At a higher level of organization than the organism or population level are those areas with distinctive biological characteristics that set them apart from surrounding areas. These areas include marshlands, barrier islands, mangrove swamps, wildlife refuges and sanctuaries, coral reefs and isolated reef-type communities, shellfish and worm reefs, kelp beds, bird rookeries, pinniped rookeries, and topographic highs that serve as commercial fishing banks. Potential impacts on these areas are more important because of the intrinsic value of the areas and the relationship and dependencies within the areas that could be disrupted by impacts on one component.

Marshlands and barrier islands can be affected by repeated oilings, but the single large oiling apparently does not prevent recovery of the area. Evidence exists that moderate oilings can produce an increase in production in marshlands. Chronic oil pollution has decidedly deleterious effects on marshlands, however. Mangrove trees have been killed by oil spills. The primary adverse impact on these areas derives from pipeline traversing. Construction and maintenance of pipelines entails channel dredging (both for the pipes and equipment access), the presence of equipment and manpower, creation of dredge spoil banks and the attendant turbidity and resuspension of toxic substances, and alteration of salinity and circulation patterns from channel creation. All these activities can result in decreases in vegetation and habitat for organisms, as well as affecting the water quality on which the spawning and breeding of many commercially valuable species depends.

Wildlife refuges and sanctuaries (including estuarine and marine sanctuaries) are created specifically for removal and protection from any man-induced activities. The introduction of possible impacts from OCS activity impinges

on this basic justification of existence, in addition to the value of the areas in purely ecological terms. The same types of activities mentioned previously could affect these managed areas, such as oil spills and pipelines; onshore facilities might also be sited in these areas. It must be noted that, in most cases, there are stringent regulations regarding activities other than those for which the managed areas were set aside.

Topographic highs or banks are distinctive features on much of the OCS, e.g., in the Gulf of Mexico. When shallow enough, they may be capped by coral reefs or reef-type communities that are extremely valuable to scientists and the public. The banks also serve as habitat for large schools of commercial fish such as snappers and groupers. These features are at some depth below the surface and would not be directly affected by spilled oil. Primary impacts would be due to sedimentation from drilling and pipe laying operations and mechanical disturbance from fixed platform siting and pipeline crossing. Sedimentation is inimical to reef communities; platforms may cause congregation of commercial fish (thus making it more difficult for fishermen to catch them) or drive them away from traditional fishing areas; and pipelines may cause fishing gear hangups. Chronic pollution by oil and other toxic substances may be injurious to both reef communities and commercial fish populations.

Shellfish and worm reefs are found in many areas of the OCS, e.g. the Atlantic and Gulf of Mexico coasts, generally in estuarine locations. Oysters and clams are among the most important commercial intertidal and shallow subtidal organisms of our coasts. Intertidal and subtidal organisms potentially suffer the most damage from spilled oil, either through smothering, fouling, or direct poisoning. Toxic lethal effects are generally rare from a single oiling; mechanical lethality is more common. However, chronic exposure appears to be more harmful than single, isolated oilings; and in chronic exposure, toxicity may be a more important impact-producing factor. Many nearshore and estuarine areas harboring large concentrations of oysters, clams, and shrimp are already stressed from sewage and industrial discharges. Additional loadings from oil spills and chronic oil pollution may reduce the commercial harvest because of tainted taste or health hazards.

The unique kelp beds in Southern California harbor a diverse community of organisms, as well as being of commercial importance. Oil does not appear to significantly damage kelp itself but may affect other organisms in the community. Some impacts to the kelp may result from laying pipe through the beds.

Rookeries exist in many areas of the U.S. coast. Bird rookeries will be threatened by human activity associated with operations, pipeline traversing, construction of onshore facilities, and oil spills. Oil spills that approach bird rookeries have potentially serious consequences because of the concentration of birds that may be found at certain times of the year. Pursuit of food may cause large numbers of birds to contact oil on the water.

Pinniped rookeries and hauling grounds are primarily threatened by human activity; in comparison, contact with oil is not as significant a problem. Platform construction and maintenance, pipelaying, and onshore construction near breeding and hauling grounds may cause abandonment of the grounds. Many pinniped species utilize only one area for breeding, and forced abandonment of a breeding area would have serious repercussions within the population. Sea otters are one group that suffer from contact with oil; like birds, their coats lose insulating qualities when oiled.

h. Impacts on Commercial and Sport Fisheries (10)

. Removal of the Sea Floor from Use

Those fisheries involved with exploitation of bottom or demersal species are impacted by the removal of fishing grounds. All sites occupied by drilling or production platforms, as well as attendant service boats and barges, must be avoided by fishing boats. Fisheries involved include shrimp (the most valuable fishery in the U.S.), lobsters, Pacific coast crabs, and bottom fish (flounders, halibut, industrial groundfish). Jack-up drilling units or permanent production platforms effectively remove two to five acres of fishing area per structure. In deeper waters (over 100 meters), a semi-submersible drilling rig with a 300 meter anchoring radius would remove up to 70 acres. The duration of the exploratory drilling ranges from about 45 days for a single well to around six months for multiple well explorations. Permanent production platforms may remain in place for 10 to over 20 years.

Structures placed on the sea floor are known to attract large numbers of fish in the Gulf of Mexico and California. (There is no evidence that these new populations are made up of displaced individuals from nearby populations). Commercial and sport fishermen work around these rigs because of the large populations of fish commonly found there. However, purse seining, which requires a large amount of area, may be somewhat restricted by close spacing of rigs and platforms. The total number of platforms required

to develop a lease area and their spacing relative to each other are important factors in considering potential impact on commercial fishing activities. In addition to the removal of the sea floor for fishing, the structures and additional traffic increase the congestion within an area, requiring fishermen to spend more time navigating and avoiding collisions.

. Creation of Obstructions

Offshore oil and gas operations create obstructions on the sea floor, such as underwater stubs, subsea completions, large pieces of debris, and buried pipelines. Underwater stubs present a hazard to trawlers in that if the net is towed across a stub, the net will certainly be badly damaged or lost.

Large pieces of debris, such as equipment, piping, structural members, tools, etc., may accidentally be lost off a platform, service boat, or barge. If these pieces are not recovered, they may cause damage or destruction of nets or other fishing gear which encounter them.

Unburied pipelines (beyond the 200 foot depth contour) may pose a problem to bottom trawl fishermen. However, about 90% of the Gulf of Mexico shrimp catch was harvested inside the 120 foot depth contour. Pacific coast shrimping grounds are generally in areas of low petroleum potential (northern California, Oregon). California trawling fishermen have indicated that unburied pipelines may pose some problems but felt that they could maneuver their vessels so as to minimize damage or loss of their nets (U.S. Geological Survey, 1974). Due to unstable bottom conditions, the gradual exposure of once-buried pipelines may present even more difficult problems offshore New England. Pipeline corridors and pipeline burial out to the 200 foot depth interval within a lease area reduces the hazard.

. Contamination of Fish by Spilled Oil

Fish which are either externally coated or internally contaminated with oil are unmarketable. Organisms living in the vicinity of chronic oil spillage are likely to be internally contaminated. The extent of contamination in offshore waters is not detectable, but it is so in some coastal areas where waterborne or water soluble petroleum products can become concentrated.

A secondary impact of oil contamination of fish and shellfish is that the marketability of these fishery products is initially reduced due to the direct health or esthetic effect of the oil. Later the fishery product may gain a poor reputation, and the economic effect may far outlast the period for which the fish are actually tainted.

. <u>Reduction of Fishing Effort Due to Spilled Oil</u>

Oil spills may reduce fishing effort, which in turn reduces the total catch. Effort reduction occurs when oil actually fouls fishing nets and gear, or the presence of oil in the water restricts fishermen from fishing for fear of fouling their gear. Landings of rockfish were greatly reduced in the Santa Barbara area because of a reduction of fishing effort caused by oil contamination of boats and gear, as well as the negative esthetic appeal of fishing in polluted waters.

Areas of chronic oil pollution may also foul fishing gear on occasion, resulting in extra expense and reduced fishing effort while cleaning or replacing the gear. This may be significant where large purse seines are used at the surface (such as for Alaska salmon).

. <u>Removal of Onshore Sites Considered for Aquaculture</u>

Aquaculture of marine organisms, such as clams, oysters, and juvenile salmon, is emerging as an industry. Pollution effects can be severe on this industry. For example, a single large oil spill in Puget Sound could destroy the area's extensive aquaculture industry. The State of Washington denied oil and gas lease applications in Puget Sound. The state considered such action incompatible with a potential multi-million dollar a year seafood cultivation industry. Future seafood aquaculture industries may refrain from establishing operations in areas associated with petroleum products if a pollution potential exists.

. <u>Sport Fishing</u>

A major oil spill will very likely adversely effect sport fishing. Boat fishermen would not want to soil their boats by fishing in the vicinity of an oil slick, and neither boat nor surf fishermen would want to keep fish that has been coated or contaminated with oil. Therefore, sport fishing would be curtailed in the vicinity and for the duration of the spill incident.

Extensive evidence exists that overall, oil and gas operations have a favorable impact on sport fishing activities. The favorable impact is the result of sports fish population enhancement due to the artificial reef effect of offshore platforms. In the open sea, offshore platforms provide both food and cover in areas that are largely devoid of these essentials. Myriad forms of micro-organisms in the water drift by these structures. The average platform in 150 feet of water provides 90,000 square feet of hard surface for encrusting organisms. Hard substrate is necessary for encrusting organisms such as barnacles, hydroids, corals, mussels, and other invertebrate organisms which serve as links in the food chain. Artificial reefs provide protection, food sources, spawning sites, and spatial orientation markers for fishes. Artificial reefs attract available fish from surrounding waters and increase the size of some populations by providing additional protected areas and food for both young and adults.

i. Impacts on Recreational Values

If pipelines which result from OCS development are brought ashore in a beach area used for recreation, there will be an impact on recreational activities. The area of a beach disturbed by pipeline construction will be small (about 30-50 feet wide), and the first high tides following burial of the pipeline will serve to restore the beach terrain. A storm tide or high winds may be necessary to obliterate the effects of excavation. Physical interference with recreational activities from excavation will be minimal and short lived.

If pipeline terminal or transfer facilities are located in or near a beach or other area used for recreation, there will be an adverse impact on recreational activities from disruption during the construction phase and elimination of about 40 acres per terminal plant for recreational uses. This latter impact would be long-term and restoration of the area, if attempted at all, would have to await depletion of the offshore production which the plant would be designed to serve. These impacts will diminish the quality of the area for recreational enjoyment.

The impacts of pipeline and terminal facilities construction on recreation would be mitigated somewhat if the appropriate governmental authorities were to allow this type of construction only during the time when recreational use of the area is at its lowest point.

The impacts from permanent terminal facilities could be mitigated somewhat by locating them at some distance inland where recreational use is not intense. State authorities may wish to consider this alternative.

Water sports, such as swimming, diving, spearfishing, underwater photography, fishing for finfish and shellfish, boating, and water skiing would also be directly affected by an oil spill. Other seashore related activities such as beachcombing, shell collecting, painting, shoreline nature study, camping and sunbathing would be made much less attractive for an indeterminate period where an oil spill had coated a beach.

Removal of oil from beaches used for recreation in the area under consideration would probably involve removal of the contaminated sand and, possibly, replacement of the sand if needed. The time required for clean-up in this case would depend on the extent of beach affected. Recreational use of the area would be precluded during the time that oil covered the beach and during the clean-up process also.

The impacts of an oil spill discussed above would be more keenly felt if the recreation area involved in intensely used for considered to have unique or outstanding recreational values. Not only would the impact be felt by the recreational users of these areas, but so would the community of businesses whose economic well-being depends on use of their recreational resources by tourists. If an oil spill were to cover outstanding recreational beaches during the height of the recreational season, the impact could be expected to be more severe in that residents and tourists would not be attracted to a beach area contaminated by oil or undergoing a clean-up process. There would be a resultant economic loss.

3. DISCHARGE OF DRILLING MUDS AND DRILL CUTTINGS (10, 21)

As the drill bit bores through the bottom sediments and the underlying native rock, it shatters and pulverizes these materials which then move up the riser to the surface where they are cleaned and discharged overboard. Mixed with the drill cuttings as they are discharged overboard can be quantities of commercial drilling muds, although much of the drilling mud is separated and retained for re-use.

Drill cuttings are not known to be toxic, and their discharge overboard should cause only minor environmental impacts. However, certain components of drilling muds are known to be toxic to aquatic organisms. Drilling muds are not normally dumped into the ocean. It is forbidden by OCS Order No. 7 (U.S. Geological Survey, Department of Interior) to dump drilling mud containing oil into the ocean. This OCS Order also forbids the discharging into the ocean of drilling mud that has been treated with chemicals of a type

or quantity that would result in the drilling mud being toxic and thus detrimental to the marine environment. The muds normally used on OCS wells, down to the surface casing setting point, consist of seawater and gel (bentonite clay) as shown below. This is a light-weight mud with few chemicals.

Gelled Sea Water Mud
Typical Composition

Mud component used	Weight (pounds)
Bentonite Clay	56,000
Caustic (Sodium Hydroxide)	5,500
Barium Sulfate (weighting agent)	12,200
Organic Polymer	3,700
Ferrochrome Lignosulfonate (Iron-2.6%, Chromium-3.0% Sulfur - 5.5%	3,300
Pregelantinized Starch	500
Seawater	as required
Total Mud Components	81,200

Below the depth of the surface casing, the mud system is generally changed to a seawater lignosulfonate system. Materials widely used are aluminum stearate for foaming control, bentonite for gelling mud, barite for weighting material, carboxymethylcellulose for reduced fluid loss, lignosulfate for a thinner and for reduced fluid loss, bicarbonate of soda for cement contamination, and caustic soda for pH control. Caustic soda is considered toxic in concentrated form. The muds that are used off-shore have pH's in the range of 7.5 to 10. The caustic soda (sodium hydroxide) used to keep the pH high (alkaline) will in the presence of sea-water and within certain pH ranges react to form calcium hydroxide, magnesium hydroxide, and barium hydroxide. The latter is insoluble and will sink immediately to the bottom because of its specific gravity.

Of some concern is the presence of chromium in many marine drilling muds as the organic complex, (ferro) chrome lignosulfonate. Overboard loss or discharge of drilling fluids would introduce some of this chromium into the marine environment. Overall recent industry tendencies towards maximum recovery of chemical additives minimize any potential hazard to marine life.

On a weight basis, chromium is present in unweighted commercial lignosulfonate drilling mud components at a concentration of about 12 parts per thousand (ppt). Required seawater additions to the mud concentrate reduce this value to less than 4 ppt. -- the approximate concentration of chromium in drilling mud, if discharged. In addition, dilution/dispersion effects associated with overboard discharge would be considerable.

Although data relating to toxicities of organic compounds containing chromium are scarce, recent work suggests that chrome lignosulfonate, in moderate to strong dilution, is relatively harmless. While readily soluble in seawater, the compound apparently dissociates very little. If inorganic chromate is also present in the drilling mud, however, oxidation of the chrome lignosulfonate occurs, evolving a new organic chromium complex. The nature of this new phase is not well understood.

Physical adsorption and ion exchange occur between chrome lignosulfonate and clay components of drilling muds. Both transfer mechanisms effect the removal of chrome components from the water column with subsequent deposition as clay sediment. Once on the sea floor, chrome lignosulfonate is fairly resistant to biodegradation, however, certain benthic invertebrates are known to concentrate trace amounts of various heavy metals over extended time. The possible role of drilling mud chromium additives in this phenomenon is the subject of ongoing research.

Normally the drilling mud is retained and used in drilling other wells on the platform. Moreover, if for any reason this is not the case, various companies will buy this liquid mud for re-sale when they have the opportunity and available mud boats to pick it up. Heavy, highly treated mud systems are expensive and economics alone normally rules out the dumping of this type of mud system. Improper disposal of oil contaminated drill cuttings and drilling muds will also be in violation of EPA's recently proposed effluent limitations for the oil and gas extraction industry. See Federal Register of September 15, 1975. Such discharges will be subject to National Pollution Discharge Elimination System (NPDES) permits issued under Section 402 of the Federal Water Pollution Control Act, as amended, upon condition that the discharges will meet the requirements under Sections 304, 306, and 307 of the same Act.

4. <u>DISCHARGE OF PRODUCED FORMATION WATERS</u> (10)

Petroleum reservoirs often have water associated with the oil and gas, and this water is called formation water or oil field brines. Some petroleum reservoirs contain substantial amounts of formation water,

whereas others contain almost none. Typically, petroleum reservoirs which have water drive produce very large volumes of formation water while gas drive reservoirs produce little formation water. Before wells are drilled into a petroleum reservoir, the amount of formation water associated with the petroleum deposits is not known. Therefore, at this time it is not possible to estimate the amount of formation water which may be associated with petroleum production from the petroleum deposits of the various undeveloped regions of the OCS. While substantial amounts of formation water will likely be discharged into the sea, a significant portion of the formation water will also be reinjected into subsurface formations either to enhance recovery of the petroleum products or, less frequently, to reduce adverse environmental impacts.

Adverse environmental impacts generated by discharge of formation waters are caused by the physical properties of the formation water and the unremoved petroleum hydrocarbons. Current operating regulations require that the hydrocarbon concentrations of any single discharge of formation waters not exceed 100 ppm and, furthermore, that the average hydrocarbon content of the aggregate of discharged formation waters not exceed 50 ppm. These standards are to be made more stringent by Environmental Protection Agency proposed and interim final rulemaking. See the Federal Register of September 15, 1975 and Chapter IV of this document.

EPA's proposed effluent limitations for the oil and gas industry eventually will eliminate discharge of formation waters, requiring physical/chemical treatment followed by reinjection. See EPA's Draft Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the Oil and Gas Extraction Industry.

The mineral content of formation waters can also generate adverse environmental impacts. At this time, the mineral content of the formation waters associated with the undeveloped petroleum reservoirs in the various OCS areas is not known. Some fields in Texas produce almost pure water whereas the average total dissolved solids of 76 samples from southern Louisiana and the OCS was found to be 112,513 milligrams per liter (mg/l) with a range from 270,000 mg/l to 61,552 mg/l. Oil fields brines commonly contain varying amounts of iron, calcium, sodium, bicarbonate, sulphate, and chloride ions. Ocean waters around the world also contain each of these ions in varying amounts.

The impact-generating potential of discharged formation waters is that the concentrations of these ions in the formation water differ from the concentrations of these ions in the surrounding waters. Discharged formation waters with higher than ambient ion concentrations will sink because they are heavier. Discharged formation waters with dissolved solid concentrations lower than the receiving ocean water will tend to float on top of the receiving water. In either case, the discharged formation waters will mix with the surrounding waters, and their mineral content after some time will become indistinguishable from that of the receiving water. Water currents in the discharge area will speed this mixing process. Continuous discharge of formation waters from OCS production will, therefore, alter the dissolved solids characteristics of the waters adjacent to these discharges. The size of the area affected will, of course, depend upon the volume of formation water discharged, the dissolved solids content of the formation waters, and the dissolved solids content of the receiving waters.

Another characteristic of formation waters which has a capacity for generating adverse environmental impacts is that formation waters are typically devoid of oxygen. Just as the unusual mineral content of formation waters can cause physiological problems for the living marine organisms in the area of the discharge, so can the lack of oxygen in these waters. However, the size of this impact will be small. As the formation waters mix with the surrounding waters, the oxygen content of the formation waters will become indistinguishable from the surrounding waters.

Not knowing either the expected volume of formation waters or their mineral content precludes quantification of the environmental impacts associated with discharge of these fluids. However, knowledge of the impact-generating potential of discharged formation waters, discussed above, indicates that the magnitude or severity of these impacts should not be large. If studies in specific OCS areas of the impacts generated by either hydrocarbon content or mineral content of formation waters indicate that unacceptable environmental impacts are created by discharging formation waters, appropriate mitigating measures will be adopted.

5. PIPELINE BURIAL (10)

Present OCS operating regulations require burial of pipeline in water depths of less than 200 feet. Present requirements for granting pipeline rights-of-way permits by the Bureau of Land Management stipulate that these pipelines

be buried to a depth of 3 feet into the sediments where the overlying water depth is 200 feet or less. Gathering lines from clustered rigs or proximate fields do not have to meet this requirement, as they are considered part of the production system. They are generally not buried, as commercial ship traffic is at a minimum close to rigs. Because they are small diameter lines, gathering lines tend to sink into the sediments by themselves. During pipeline burial, a large volume of bottom sediments are disrupted and resuspended for a short time in the overlying waters. The dimensions of pipeline burial excavations vary considerably depending upon the nature of the bottom sediments. This makes it difficult to calculate a reasonably accurate volume for the materials disrupted. At some future date, when exact pipeline routes are drawn for each OCS area, the volume of disrupted bottom sediments can be calculated with some accuracy.

In general, the environmental impacts of pipeline burial are very similar to those of discharges of drill cuttings and drilling muds.

a. Dredging in nearshore areas will often result in resuspension of many years accumulation of such materials as organic matter, phosphates, and other nutrients, as well as toxic heavy metals and pesticides. The heavy metals and pesticides are of particular concern because resuspension of these materials will allow them to exert their toxic effects until they are gradually reincorporated into the sediments. The disruption of the organic matter and nutrients will increase the biochemical oxygen demand (BOD) and could lead to localized problems of insufficient dissolved oxygen to support life. The potential impacts associated with increased BOD should be of short duration.

b. On hard bottoms, dredging will eliminate suitable sites for attachment of the biotic communities dependent upon hard substrate attachment (sponges, soft and hard corals, seaweeds, sessile molluscs). This impact will persist throughout the pipeline burial path either permanently or until the substrate gradually becomes compacted.

c. Both pipeline burial and discharge of drill cuttings and drilling muds can smother the burrowing and attached benthos. This can occur where these materials settle to the bottom and accumulate to significant depths.

d. Pipeline burial, like discharges of drilling muds and drill cuttings, increases turbidity in all locations where these activities occur. The small sized particles causing this turbidity can clog the respiratory organs of many marine organisms and the filter-feeding mechanisms of numerous others.

e. In coastal wetlands and uplands, pipeline burial operations will displace many species of wildlife during construction and maintenance operations. The effects of pipeline burial in wetlands can have a substantial impact of one to several years duration as a result of devegetation and disruption of substrate. An additional significant impact of pipeline burial in coastal estuaries can result from disruption of the water circulation patterns.

F. SHIPYARD CONSTRUCTION AND REPAIR

1. EXPANSION OF FACILITIES

In the event of a conventional, long term global war or a critical oil and gas shortage in which the current construction program would not fill the needs of the national emergency, it may be necessary to expand the capability of existing shipyard facilities. The probability of this occurring is extremely remote due to the long lead time involved in the expansion of a shipyard. Rather, it would first be prudent to examine yards that could build offshore oil and gas drilling vessels and, for economic and other reasons, had declined to enter into such construction or preferred to build ships.

The major constraints to the building of large offshore oil and gas drilling rigs are:

a. Sufficient space within a wet basin or launching facilities if a basin is not used.

b. A crane with a minimum lifting height of 250 feet must be available in order to effectively serve the construction demands of the large oil rigs.

c. Bridges along the rivers downstream of the shipyard must be of sufficient width and height to permit the oil rigs to be moved from the shipyard to the open sea.

These constraints, however, would not preclude the construction of components of a large oil drilling rig and floating or barging them down river to an assembly site.

Only as a last resort would shipyard expansion of any significance be undertaken, and the project would be subject to extensive review by the U.S. Army Corps of Engineers and to hearings which are open to the public. Environmental Impact Statements (except in the case of war) may be prepared for each shipyard expansion and specific attention to the environmental setting of the activity will be required.

Expansion of existing shipyards, which are in most cases located in already highly industrialized areas of a waterfront, would generally require certain disruption of the adjacent shoreline. Such disruptions may be caused by filling, dredging, pile driving, excavation, bottom stabilization, and/or other hydraulic works depending upon the nature of the expansion.

When suitable land area adjacent to the existing facility is not available due to the configuration of the shoreline, location of other industrial plants, proximity of residential sections, or for other reasons, then such land must be created by filling suitable sections of the waterway on which the expansion is contemplated. Additional dredging of access channels to the construction and repair facilities may be required in certain cases because of the relatively deep draft and excessive width of large semi-submersible rigs. Any such dredging and spoil disposal would have an impact on the environment and would, therefore, fall within the jurisdiction of the Army Corps of Engineers.

Creation of new acreage by filling existing waterways, whether for expansion of a shipyard or building a new one, causes a permanent impact on the waterway by diminishing its navigable and recreational area. The filled bottom ceases to provide natural habitat and possible spawning grounds for marine life. However, the new shoreline, which is generally stabilized by steel bulkheads, may provide protection for aquatic organisms, especially in localities with strong current or tidal turbulence. Construction

of a new shipyard on land which requires little or no filling would, of course, have a lesser impact on the ecology, although former wildlife value and biologic productivity will be lost. The disturbance to the environment caused by filling, pile driving, and other hydraulic activities will be of a permanent nature, changing the physical environment, and hence, also the associated biota. Once construction is complete, a new final biological balance will set in.

It is self-evident that in areas where profitable harvesting of shell fish has been going on for years, any disturbances to the marine environment, such as filling, will be more objectionable from a commercial point of view than filling in areas in which such activities never took place. In constructed areas or in the vicinity of navigable channels, the filling may cause problems to a degree where it may not be permitted at all or diverted to some other location.

Recreational aspects of waters which may be affected would also be considered when such planning is in progress. While the waterways confined by industrialized shorelines generally serve only the purposes of transportation, any water sport activity such as boating, sailing, swimming, and fishing will utilize such waterways only in transit on the way to more desirable locations.

Infringing on adjacent marshlands, when such are found in generally industrialized areas, may have detrimental effects on migratory waterfowl, especially when located along established flyways. In addition, the loss of these lands could have a significant deleterious effect on the aquatic biota of the region, especially if the total area of marshland in the region is small.

Though the number of people residing in the areas of industrialized waterfronts will generally be small, in certain instances, individual cases of dislocation may be necessary. Such cases may cause hardship to people involved, who would probably be in the low income bracket.

Last but not least, the expansion may destroy prominent landmarks, such as old buildings of historical interest, old tree stands, arable lands, and may also affect in a negative way the aesthetic value of the land as the case may be.

While under construction, the facility will contribute to the pollution of water, mainly through disturbances to the bottom, creating continuous high silt loads and stirring of substances which in suspended state are harmful to aquatic life. A result of these conditions will be a temporary reduction in primary productivity due to increased turbidity. In addition, if organic-rich sediments are resuspended in the water column, the dissolved oxygen concentration in the region could be significantly reduced with resulting deleterious effects on nearby aquatic biota.

Among the organisms which could suffer from the above effects are anadromous fishes whose migratory runs could be interfered with, resulting in a reduction in reproductive success. Additional pollution will be caused from the shore run-offs, which in addition to organic matter may contain toxic elements or oil leaking from earth moving equipment and other power machinery. Environmental laws and regulations establish standards for controlling or eliminating such discharges. Open hearings conducted by the U.S. Army Corps of Engineers before construction is started would disclose the methods proposed by builders to adhere to Federal, State, and local regulations.

Erosion of the shoreline may be considerable unless the run-off can be controlled by installations, such as vegetative ground cover, concrete or steel bulkheads, and/or diversion of run-off water through planned canalization or sewer systems during the period of construction. This will be especially pronounced in areas where sandy or clay-type soils are predominant.

A certain amount of run-off can be expected as an infinite nuisance when a large land area is sealed by concrete or other man-made material instead of water-absorbing grass or root mat covering. Such run-offs can be aggravated by accidental oil spills or by dilutable substances, which may be picked up by heavy rain waters and which may be present in the area as part of materials used in the process of drill rig construction.

Modern shipyards built along the lines of advanced technology, equipped with modern processing machinery and progressive mechanization and automation, and equipped with the latest pollution control devices, may become competitive on the global scale affecting in this manner our balance of payment in the international market to the advantage of the entire country.

2. POLLUTION FROM CONSTRUCTION AND REPAIR OF DRILLING RIGS

Shipyards engaged in construction of drilling rigs are located in industrial areas, generally far removed from residential areas. The shipyard facilities in which the work is done include: (1) buildings which house steel preparation and manufacturing equipment, (2) machine shop, pipe shop, sheet metal shop and others in which material that goes into the hulls is manufactured or otherwise processed; (3) outside storage space in which steel plates are stored; (4) outside plate or other steel assembly areas in which modules or small hull sections are assembled; (5) the shipway or building dock in which the hulls are erected.

Part of the drilling construction process is done indoors where pollution control can be effectively practiced. The work that is done outside of buildings, in particular, erection of the hulls, presents greater problems in abating pollution.

In addition, the U. S. Federal regulations on pollution control in industrial activities, State and local regulations apply to areas in which shipyards are located. A status report from the Shipbuilding/Repair Industry Shipping SubCouncil of the National Industrial Pollution Control Council (NIPCC) dated September 30, 1971, advises that while tangible improvements in environmental quality in shipyards have been made, additional steps are taken as technology in pollution control are developed and as Federal, State, and regional regulations are formulated as guidelines in the conduct of shipyard operations.

Four principal types of pollution are identified with the construction of drilling rigs: air pollution, water pollution, land pollution, and noise pollution.

. <u>Air Pollution</u>

The sources of air pollution fall into three types: products of combustion, airborne particulates, and airborne fumes and vapors.

Products of Combustion - Combustion products from yards' boilers and incinerators, smoke from burning and welding operations, exhaust from internal combustion engines and soot from boilers contribute to air pollution.

To reduce pollution from these sources, the major shipyards report only intermittent use of boilers and in some yards natural gas or low sulfur fuel is used to fire yard boilers. Use of incinerators has been discontinued in favor of having waste removed by licensed disposal firms. Smoke from burning and welding operations and internal combustion engines is generally exhausted to the atmosphere.

Airborne Particulates - Dust resulting from abrasive blasting, dust created by woodworking machinery and dust due to unpaved roadway surfaces contribute to pollution from airborne particulates.

The problem of airborne particulates from abrasive cleaning is the most difficult to control. The major builders of drilling rigs have installed enclosed abrasive cleaning facilities of major size for cleaning raw stock steel and modular assemblies. The September 30, 1971 NIPCC report advises that abrasive cleaning and painting of hulls on the shipways or at outfitting berths is the subject of an intensive cooperative industry study by the Environmental Control Committee of the Shipbuilders Council of America with representation from the shipbuilding, ship repair, paint, coating and steel industries. Dust collecting systems have been installed in some of the yards for collection of woodworking dust. The yards with unpaved roadways periodically oil and water the roads; however, this practice has been largely discontinued in favor of some form of paving.

Airborne Fumes and Vapors - Overspray of protective coatings, evaporation of toxic chemicals and solvents, leakage of toxic or explosive gases in piping, fuel tank venting of explosive vapors, odors from sanitary facilities, and photochemically reactive hydrocarbons in paints and solvents are among the shipyard airborne fumes and vapors.

The problem of painting overspray on the shipways or outfitting berths is under study along with abrasive blasting. One major builder reports approximately 75 percent of painting is done in enclosed areas where overspray is collected by media type filters. Airless spraying equipment is used as much as possible. Regularly scheduled tests are made in pipelines for toxic or explosive gases. Flame arrestors and stops are installed in fuel tank vent lines.

. <u>Water Pollution</u>

The basic types of discharge that could emanate from shipyards and pollute the waterways fall into two broad categories: liquids and solids.

Liquids - Liquids include chemical make-up plus suspended solids and thermal change. Sanitary waste discharges, discharge of process chemicals, petroleum spills, overflow and leakage, overspray and spillage of protective coatings and discharge of cleaning fluids are among the liquids that contribute to water pollution. Sanitary waste discharges are disposed of through municipal sewer systems. Collection of process chemicals and cleaning fluids for removal by outside contractors is practiced by the major drilling rig builders. Oil spill crafts with booms and other procedures are in use to handle accidental oil spills. Paint overspray and spillage have been minimized by the use of airless spray equipment and rollers.

Solids - Overboard discharge of spent abrasives, waste and scrap materials, debris from launching ways or deteriorated waterfront structures and disposal of dredging spoils are among the solids that contribute to water pollution.

Builders of drilling rigs enforce strict regulations on controlling the discharge of spent materials, i.e., grit, rust, scale, and paint residues into the waterways. In the construction process most of the blasting is done indoors under controlled conditions. Building docks and shipways are cleaned after the blasting operation, and in some of the yards abrasive material is reclaimed. One major shipyard disposes of abrasive materials by making land fill.

Overboard discharge of waste or scrap materials is against shipyard policy. Debris from launching ways is retrieved by yard water patrols. This is primarily a function of launching a ship. Disposal of dredging spoils is controlled by the Corps of Engineers through the designation of dumping sites.

. <u>Solid Waste and Other Pollution</u>

Solid waste and other pollution sources include a broad variety of materials used in the various shipbuilding processes and operations. Grit, rust, scale, metal, and paint chips from abrasive cleaning of steel on shipways and outfitting berths are difficult to control. As previously noted, this problem is the subject of a cooperative industry study.

Petroleum spills from fuel handling and storage and machinery operation; metallic residues from welding and brazing operations; paint residues from coating processes; solvent spills from cleaning operations; metal scraps and particles from flamecutting operations; sand and resin dust from casting

operations; and chemical spills from galvanizing all contribute to this pollution. The major drilling rig builders have installed devices and methods to abate much of the pollution from these sources.

. Noise Pollution

The major noise pollutant sources in drilling rig construction have been identified as diesel and gas power source exhausts, high capacity vent fans, percussion tools and air operated tools. The industry is combating noise through the use of mufflers, silencers, equipment modifications, incorporation of noise standards in specifications for equipment and restricted use of horns and whistles.

3. USE OF MATERIALS

Drilling rigs are built primarily of steel. Steel is used in the hulls, machinery, piping and almost all the other systems. In fact, 96 percent of the rigs' weight is composed of steel and steel alloy. The second most important material is copper which is used in the electrical systems, and propellers of the self-propelled rigs. The remainder of the rigs use small amounts of a large number of materials.

The major producers of steel for the commercial shipbuilding industry are:

	City
Lukens Steel	Coatesville, Pennsylvania
U.S. Steel/American Bridge	Orange, Texas
Bethlehem Steel	Bethlehem, Pennsylvania
Bethlehem Steel	Sparrows Point, Maryland
Kaiser	Fontana, California
U.S. Steel	Salt Lake City, Utah
Bethlehem Steel	San Francisco & San Pedro, California

The geographical source of the remaining 5 to 10 percent of the material weight used is so diverse that a detailed analysis is difficult. While not significant in weight, they represent 75 percent of the material cost of a drilling rig. This includes manufactured items such as:

Propulsion and Auxiliary Machinery	Deck and Drilling Machinery
Shafting, Propeller	Electrical Installation
Motor, Pump	Accommodations
Pipe, Cable	Ventilation
	(Many others)

4. REPAIR OF DRILLING RIGS

The stationary and mobile drilling rigs operating in American waters are subject to regulations of the U.S. Coast Guard, Public Health Service, Federal Communication Commission and the American Bureau of Shipping. Consequently, the rigs, subjected to normal wear and tear under operational conditions, require continuous maintenance and repair which varies to some degree from that of sea-going merchant ships.

While for sea-going ships most repairs would be effected in port, minor ones at the cargo piers and major ones in the repair yards, the large drilling rigs will usually be repaired at their operational site, far away from the shore line.

Only exceptionally heavy damage to underwater components that absolutely cannot be repaired afloat would force an operator to move a rig to the closest shore-based repair facility. In this event the repairs would have to be done afloat as dry-docking of these rigs due to their large size and awkard configuration would be impossible.

In the case of mobile rigs such as drilling barges and shipshapes, docking would be possible, and any major repairs done to them would employ the methods used for any sea-going ship.

In essence, the pollutants generated by drilling rig repairs are the same as those created in the ship repair process. These fall into the following categories:

<u>Air Pollution</u>

- Combustion products, including internal combustion engine exhausts, welding and burning, and boiler operations;
- Particulates resulting from blasting and painting;
- Fumes and vapors resulting from evaporation of paint solvents, fuel tank venting, and refuse and sanitary odors.

Water Pollution

- Overboard discharges of spent chemicals, sanitary wastes, and refuse and trash.

Noise Pollution

- Sounds of mechanical equipment in operation;
- Horns, whistles, etc.;
- Air-operated percussion tools;
- Rapid expansion of gases.

All three modes of pollution should be considered only where the rigs are brought for repairs to yards while, as mentioned above, during all repairs at operational sites, far away from the shore line only the water pollution may have any detrimental effect on the environment.

Because of better equipment and longer-lived coating, the new drilling rigs being built under the Title XI program will not require as much maintenance and repair work as older vessels do.

Problems of oil pollution of water resulting from the need to wash and gas free bunker tanks of self-propelled rigs prior to accomplishing hot work in the tank have been resolved. Shipyards collect the "slops" of tank cleaning into a barge or collection tank for disposal. No contamination of sea or harbor waters is experienced.

G. PROCESSING OF OIL AND GAS

1. OIL REFINING (10)

Although total national oil refinery capacity has expanded relatively slowly in recent years, it is likely that capacity will grow more rapidly in the next decade. All or much of this growth will occur whether the OCS is developed or not. If the OCS is not developed, oil that could have come from the OCS will very likely be imported from abroad; and much of this oil will be brought to the U.S. in crude, rather than refined form. Hence the "base case against which environmental impacts due to OCS - induced refinery operations is rather small if not zero.

The environmental impact of OCS - induced new capacity might differ somewhat from the impact of new capacity to accommodate imported crude mainly because of the location of the new capacity might be different under the two cases. In practice, however, this displacement process should not occur to any great extent. The economics of refinery siting have less to do with proximity to sources of crude than with proximity to markets for the refined products and access to transportation networks.

An economically viable capacity for a new refinery presently in the planning stages is approaching 200,000 bbl. /day. Such a refinery requires 650 acres for all refinery facilities and storage tanks. However, 1,200 acres is generally regarded as the minimum requirement for a new refinery site. This allows space for expansion and buffer.

New refineries are expected to shift toward closed water systems and air cooling systems to reduce water requirements. Most air and water pollution loadings are not expected to present major problems for future refineries because of improved technologies for pollution control and treatment. The main areas of concern regarding refinery effluent water discharges are increases in total dissolved solids, oil, and biological oxygen demand. The primary air pollution concern is hydrocarbon emissions, which will probably continue to pose significant control problems. This is an important constraint to refinery development in areas where hydrocarbon emissions are already a problem. Electric power requirements for refineries are estimated at 630,000 KWH/day per 100,000 bbl of oil refined.

2. GAS PROCESSING (10)

There is presently a great demand for gas fuels due to the shortage of natural gas supplies which has resulted in curtailment of gas deliveries under existing contracts. The capital investment requirement for a gas processing plant is much less than that required for a refinery. Due to smaller resource requirements of land, water, and electricity and the much smaller degree of air and water pollution, there has not been much opposition to gas processing plants on environmental grounds.

Natural gas once produced is sold to a transporter/distributor, but the oil company reserves the right to process the gas before it enters the distribution system. At a gas processing plant the butanes and propanes are stripped from the natural gas after the separation of oil and water has taken place. The stripping of butanes and propanes is not necessary but is desirable as propanes and butanes are in high demand and have high economic value.

OCS development in frontier areas would stimulate additional gas processing capacity if natural gas resources could be developed into economic reserves. In a decision to site a gas processing plant, the most important factors are locating near the market, the source of production, and the distribution system. For example, in Alaska, where the market for butanes and propanes is low, plants would locate in the lower 48 States. Natural gas would be transported via pipeline to the market areas, processed, and trucked to distribution points. On the Atlantic coast, where there is a high market demand and an available distribution system but no production, significant growth of gas processing plants as a direct result of OCS development would be expected. In producing areas like the Gulf of Mexico where gas processing plants are already extensively developed, it is expected that further OCS production would replenish depleted supplies, therefore increasing capacity utilization.

Given the overall importance of market location, producing areas, and proximity to the distribution (pipeline) system, the siting of gas processing plants, like that of refineries, will ultimately depend upon State and local zoning ordinances, coastal zone regulations, and air and water quality standards.

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CHAPTER IV

MITIGATING MEASURES NOW REQUIRED IN CONSTRUCTION AND OPERATION OF OIL AND GAS DRILLING VESSELS

The mitigating measures associated with vessels engaged in offshore oil and gas drilling operations are those statutes and regulations that apply to the general construction and operation of vessels that navigate in the navigable waters and contiguous zone of the United States and those regulations that apply to vessel operations in the exploration of oil and gas. Therefore, this section will discuss those mitigating measures as well as those regulations, statutes and conventions that apply to the general concept of jurisdiction of the outer continental shelf.

A. INTERNATIONAL STANDARDS

1. JURISDICTION

Under the Convention on the Continental Shelf, (1) the United States has exclusive rights over its adjacent continental shelves for the purpose of exploiting their natural resources to a depth of 200 meters and beyond that to where the depth of the superjacent water "admits of the exploitation of the natural resources."

Subsequent to this Convention, the Third United Nations Conference on the Law of the Sea was convened to develop a regime for governing the oceans of the world. The first and second sessions held in Caracas, Venezuela, June 29, 1974 - August 25, 1974 and Geneva, Switzerland, March 17, 1975 - May 9, 1975, respectively did not result in the adoption of a comprehensive treaty. However, the Geneva Conference did result in the development of Informal Single Negotiating Texts. These texts were prepared by the Chairmen of the three main committees. While these Informal Single Negotiating Texts are not considered as negotiated or consensus text, they do represent a take off point for future negotiations. The texts deal with the following subject areas:

Committee I -	Convention on the Sea-Bed and the Ocean Floor and the Sub-Soil thereof beyond the Limits of National Jurisdiction.
Committee II -	Territorial Sea and the Contiguous Zone, Straits Used for International Navigation, Exclusive Economic Zone, Continental Shelf, High Seas, Landlock States, Archipelagos, Islands and Enclosed and Semi-Enclosed Seas.

Committee III - Protection and Preservation of the Marine Environment.

Another session of the Third U.N. Law of the Sea Conference has been scheduled for eight weeks commencing March 15, 1976, in New York at which time the Conference will try to reach a final treaty on a regime to govern the world's oceans.

2. TECHNICAL VESSEL REQUIREMENTS

The Intergovernmental Maritime Consultative Organization (IMCO) at the 1973 International Conference on Marine Pollution adopted mandatory special requirements for the control of pollution from fixed and floating drilling rigs.

The major requirements are outlined as follows:

- As far as practicable they shall be equipped with an oil discharge monitoring and control system or with oily water separating equipment and an effective filtering system the effluent from which does not exceed 15 ppm of oil in water. An alarm system must also be provided to indicate when this level cannot be maintained.

- Sludge tanks shall be provided to receive the oily residues (sludges) that result from the purification of fuel and lubricating oils and oil leakages in machinery spaces.

- A record shall be kept of all operations involving oily or oil mixture discharges in a form approved by the IMCO Administration.

- The discharge into the sea including special areas, of oil or oily mixture shall be prohibited except when the oil content of the discharge without dilution does not exceed 15 ppm.

In addition, the 1973 IMCO Marine Pollution Conference adopted regulations for the control of sewage and garbage, Annexes IV and V, respectively, of the 1973 International Convention for the Prevention of Pollution from Ships which also apply to oil and gas drilling vessels.

B. FEDERAL STANDARDS

Under the Submerged Lands Act (2), state ownership of the resources beneath U.S. navigable waters, discussed later in this Chapter, is

subject to the Federal Government's reserved powers, including navigation rights and powers of regulation for security, economic, environmental, and other Federal purposes. There are a wide range of Federal regulatory statutes and programs that apply to the area of state resource ownership.

Beyond the area of state jurisdictions the Federal Government has exclusive jurisdiction and control over the seabeds and subsoil subject to the international limitations. The major Federal statute for exercising control is the Outer Continental Shelf Lands Act. (3) In addition to making the resources of the OCS subject to Federal "control and power of disposition," the act extends the Constitution and Federal laws to the OCS and the productive activities upon it. Among the Federal laws so extended, of course, is the National Environmental Policy Act. (4)

1. DEPARTMENT OF THE INTERIOR

Oil and gas leasing and operations in the Outer Continental Shelf outside the U.S. territorial sea are administered by the Department of the Interior (DOI) under the Outer Continental Shelf Lands Act, Titles 30 and 43 of the Code of Federal Regulations and various published OCS operating orders. Within the department, the Bureau of Land Management (BLM) administers the leasing provisions of the Outer Continental Shelf Lands Act and the U.S. Geological Survey oversees development of a tract once it has been leased and provides technical information to BLM.

(a) Technical Requirements

A general description of operating requirements under the above mentioned regulations are as follows:

- Plans: Operating plans must be submitted by the operators and approved by the Geological Survey (GS) before each stage of operations is initiated (exploration, development, abandonment). Approval of all operations must be obtained prior to their commencement.

- Operator Inspection and Testing: The operator is required to inspect all aspects of the safety systems at specific intervals, e.g., daily pollution inspection on manned facilities, "frequent" inspection on unmanned facilities, monthly test of check valves. Detailed records of inspections and tests are required.

- Reports: The operator is required to report all spills or leakage of oil to GS without delay. He is also required to notify GS of any unusual condition, problem or malfunction within 24 hours.

- Safety Devices: Required safety devices on exploratory drilling wells include well casing and cementing, blowout prevention equipment, mud programs, well control surveillance and training, and hydrogen sulfide safety programs.

- Waste Disposal: The lessee is prohibited from disposing into the ocean any oil (except that oil in produced formation water must average no more than 50 ppm), untreated waste material, or other materials which may be harmful to aquatic life or wildlife. Any drilling mud which may contain toxic substances must be neutralized before it can be disposed of in the ocean. Drill cuttings and sand must be processed, and oil removed, before they can be disposed of in the ocean*.

- Site Clearance: When an installation is no longer needed, the well is plugged with cement and all casings and piling must be severed and removed to at least 15 feet below the ocean floor and the location must be dragged to clear the site of any obstruction.

- Debris: Regulations and OCS Orders prohibit the disposal of debris into marine waters. Solid waste must be either incinerated or transported to shore for disposal in accordance with applicable requirements under State and Federal Law.

- Contingency Plans and Equipment: The operator is required to have an approved plan for controlling and removing pollution which provides for:

    (1) Standby pollution control equipment, including containment booms, skimming apparatus, and approved chemical dispersants immediately available to the operator at a land based location.

    (2) Regular inspection and maintenance of such equipment.

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*Waste disposals must comply with the 1972 Amendments of the Federal Water Pollution Control Act. Permits for disposals must be obtained from EPA under the National Pollutant Discharge Elimination System.

(b) Inspection

Evidence of compliance with the regulations and lease requirements is obtained through surveillance of the operations under the enforcement of specific requirements. The inspection system of the Geological Survey (GS) includes: (1) review and approval of plans before each operating stage is initiated, (2) close review and follow-up as necessary, by GS inspectors, of all reports required of the operator by the regulations and orders, (3) on-site inspection and (4) aerial monitoring through the use of helicopters (operators are also required to inform each other of oil spills or other irregularities which they observe).

- Operator Reports: A comprehensive reporting system covering all oil spills and any unusual conditions (for example: reporting and investigation of a persistent oil slick from an unknown source such as a sunken ship or natural oil seep) is required by the orders and is a key factor in monitoring operations. Operators are also required to maintain records for GS inspection of required periodic tests of safety equipment. Compliance with reporting requirements can be assured only periodic on-the-site inspection and aerial monitoring.

- On-Site Inspection: During the course of drilling, all operations are inspected at least one time. Leases in certain areas or in a particular development stage may require more inspections to assure the achievement of safety objectives. GS is continuing the systematic inspection program and a more stringent enforcement policy. This has resulted in increased operator compliance and better documentation of inspection results.

- A complete drilling inspection is normally conducted on each drilling rig approximately every six weeks. Random inspections may be made more frequently. Depending on the number of drilling rigs in each District, the frequency of inspections on a rig may vary from six to twelve per year.

- Aerial Monitoring: "Fly-overs" of the OCS operating area are programmed on a seven day per week basis by GS inspectors. Any indications of oil pollution or other non-compliance will be followed immediately by an on-site inspection.

(c) Enforcement

The enforcement policy is intended to: (1) reduce the frequency of non-compliance with lease requirements which may lead to loss of life, loss of property, or damage to the environment; and (2) maintain a uniform enforcement policy to be applied to all operations affecting OCS lands in the Gulf of Mexico. When, in the course of an inspection, a requirement pertaining to the prevention of oil pollution or any other safety hazard is found to be in non-compliance with regulations and lease requirements the operation will be shut-in until it is brought into compliance. After a shut-in, the operation can only be resumed by authorization of the GS; in all cases, this requires reinspection or a waiver of the inspection requirement. Minor incidents of non-compliance may require only a warning that corrections be made within a week. The operations will be shut-in if the required corrections are not made.

Additional penalties for non-compliance are specific in the Outer Continental Shelf Lands Act, Sec. 5(a)(2). "Any person who knowingly and willfully violates any rule or regulation prescribed by the Secretary for the prevention of waste, the conservation of the natural resources, or the protection of correlative rights shall be deemed guilty of a misdemeanor and punishable by a fine of not more than $2,000 or by imprisonment ..., and each day of violation shall be deemed to be a separate offense." Also Sec. 5(b) (1) and (2) provides for cancellation of non-producing and producing leases by notice subject to judicial review or appropriate judicial proceedings.

(d) Structures

If a ship strays from established safety fairways, oil and gas platforms can pose a hazard to commercial shipping. This hazard, however, is minimized by the fact that safety fairways are clearly designated on navigation charts. Directional drilling from outside safety lanes is used to develop tracts lying partially in safety lanes. Pertinent portions of the Federal Regulations (33 CFR Sec. 209.135 (b)), governing shipping fairways and anchorage areas are as follows:

> "The Department of the Army will grant no permits for the erection of structures in the area designated as fairways, since structures located therein would constitute obstructions to navigation. The Department of the Army will grant permits for the erection of structures within an area designated as an

anchorage area, but the number of structures will be limited by spacing as follows: The center of a structure to be erected shall be not less than two (2) nautical miles from the center of any existing structures. In a drilling or production complex, associated structures shall be as close together as practicable having the consideration for the safety factors involved. A complex of associated structures, when connected by walkways, shall be considered one structure for the purposes of spacing. A vessel fixed in place by moorings and used in conjunction with the associated structures of a drilling or production complex, shall be considered an attendant vessel and its extent shall include its moorings. When a drilling or production complex includes an attendant vessel and the complex extends more than five hundred (500) yards from the center of the complex, a structure to be erected shall be not closer than two (2) nautical miles from the near outer limit of the complex. An underwater completion installation in an anchorage area shall be considered a structure and shall be marked with a lighted buoy as approved by the United States Coast Guard."

Development of the tracts which lie partially within shipping fairways or anchorage areas if leased will be subject to Federal regulations as presented above so far as placement of structure is concerned and this would help mitigate any potential impact due to the proximity of structures to relatively high frequency sea traffic.

Commercial vessels are required to report to the Coast Guard whenever a casualty results in any of the following: (a) actual physical damage to property in excess of $1,500, (b) material damage affecting the seaworthiness or efficiency of a vessel, (c) stranding or grounding, (d) loss of life, (e) injury causing any person to remain incapacitated for a period in excess of 72 hours; except injury to harbor workers not resulting in death and not resulting from vessel casualty or vessel equipment casualty. Drilling and production platforms (artificial islands) are required to report to the Coast Guard when involved in a casualty or accident and if any of the following occur: (a) if hit by a vessel and damage to property exceeds $1,500, (b) damage to fixed structure exceeds $25,000, (c) material damage affecting usefulness of lifesaving or firefighting equipment, or (d) loss of life.

Under some conditions, offshore drilling operations are an obstacle to commercial fishing activities. Depending on currents and underwater obstacles an offshore structure can remove areas of trawling and purse seining waters. Heavy concentrations of platforms can make trawling and purse seining difficult.

The erection of more structures on the OCS may affect commercial fishing operations. The impact from platforms may be kept to a minimum, however, by only allowing those structures necessary for proper development and production of the mineral resources, and by placing them with due regard to fishing operations and other competing uses which are evident at the time of platform approval.

The Area Oil and Gas Supervisor considers the views of commercial fishing organizations such as the Gulf State Marine Fisheries Committee with regard to placement of platforms. The Supervisor also from time to time requests information from the Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service to be used in his decision-making process of approving or disapproving platform installation. With the constraints of location of the reservoirs and the technology necessary to drill directional wells, the Supervisor is mindful that platform location is an important consideration for commercial fisheries and does make decisions to minimize the impact of platform location on the commercial fishing industry.

2. U.S. COAST GUARD

The Coast Guard is the primary agency responsible for the enforcement of federal ship safety laws as well as those pollution abatement regulations pertaining to ship-generated pollutants. To carry out these functions, that agency maintains a specialized staff throughout the U.S. and at selected overseas ports. Those officials are involved in all phases of Mobile Offshore Unit construction and operation. Coast Guard involvement in the design of a unit begins with the submission of initial plans and specifications for approval by the agency. Each unit which is required to be inspected, is periodically inspected while under construction or alteration to ensure that approved plans are being followed. Throughout the vessel's operating life, it is regularly inspected to maintain compliance with safety regulations.

Rules and Regulations for Cargo and Miscellaneous Vessels, 46 CFR Subchapter I, Marine Engineering Regulations, 46 CFR Subchapter F and Electrical Engineering Regulations, 46 CFR Subchapter J, are the basic regulations and are generally applicable to self-propelled Mobile Offshore Units of 300 gross tons and over. Additionally these regulations are applicable to non-self propelled floating drilling units over 100 gross tons (Seagoing Barges).

The provisions of the Safety of Life at Sea Convention, 1960, are applicable to floating Mobile Offshore Units if such units are self-propelled, 500 gross tons or over and engaged on international voyages.

Mobile Offshore Units which drill only in the bottom bearing mode such as the "jack-up" or "submersible" type do not presently come under inspection as vessels. The Coast Guard imposes limited requirements on these units, which may be found in the Rules and Regulations for Artificial Islands and Fixed Structures on the Outer Continental Shelf, 33 CFR Subchapter N and the Appendix thereto pertaining to Aids to Navigation.

For several years, Industrial or Special Purpose Vessels have been under discussion at IMCO. The expansion of the oil industry to all parts of the world have kindled an interest in arriving at a suitable international agreement regarding the Safety of Mobile Offshore Units. Nations which, heretofore, were only casually interested now find a need to develop national standards which would apply to units and platforms within their National Jurisdiction. The United Kingdom and Norway have published proposed regulations. Existing regulations previously described, do not provide a concise national standard from which the U.S. delegation may work. This is primarily because existing regulations are oriented to Merchant Vessels whose basic function is considerably different from the Mobile Offshore Unit. The Coast Guard has requested assistance from the National Offshore Operations Industry Advisory Committee to the Coast Guard's Marine Safety Council and an intensive effort is presently underway to develop a new regulatory package, several changes to present inspection schemes will take place. The most significant of which will be that the "jack-up" and "submersible" type units will be subject to the new vessel inspection regulations.

The Coast Guard is also responsible for the implementation enforcement of those regulations which apply to general construction and operation of the vessels. In the area of pollution abatement the Coast Guard administers the regulations particularly the 1972 Amendments of the Federal Water Pollution Control Act that apply to the discharge of such pollutants as oil, sewage and hazardous materials and the 1972 Ports and Waterways Safety Act.

Specifically, the Coast Guard enforces regulations that mitigate the potential for oil pollution from vessels fall into several categories: standards for design and construction, fire protection requirements, and navigating equipment necessary for safe operation.

The effectiveness of the enforcement of the pollution abatement regulation is considerably enhanced by the provision in the regulation (33 CFR 151.20a) which permits Corps of Engineers employees, Bureau of Customs employees, and Coast Guard officers and enlisted personnel to enforce the regulations, including the swearing out of warrants and the making of arrest.

3. ENVIRONMENTAL PROTECTION AGENCY

Under the Federal Water Pollution Control Act Amendments of 1970 and 1972, (5) the Environmental Protection Agency has comprehensive regulatory authority over discharges of pollutants into U.S. navigable waters, including the territorial sea, and into the high seas from U.S. point sources other than vessels.

One of the major features of the Act is the National Permit Discharge Elimination System (NPDES) which prohibits the discharge of pollutants into the above waters without a permit from EPA approving this discharge.

To implement this new Permit System, the Act charges EPA with publishing regulations providing "guidelines" for effluent limitations for point sources. These guidelines will provide three basic things:

- First, they will define "Best Practicable Control Technology Currently Available" (which are to be achieved no later than July 1, 1977) and, "Best Available Technology Economically Achievable, (which are to be achieved no later than July 1, 1983). Definitions for these two levels of effluent reduction will be developed for each and every industrial group requiring permits, including the offshore oil and gas industry.

- Second, they will contain the formulae for determining what "effluent limits" are to be imposed. In these guidelines, the degree of effluent reduction attainable through the application of the best practicable control and best available technology in terms of amounts of constituents and chemical, physical, and biological characteristics of pollutants, will be identified. These guidelines can then be applied in setting specific effluent limitations on discharges.

- Third, the guidelines will identify control measures and practices to eliminate the discharge of pollutants.

As previously stated, polluting discharges of the offshore oil and gas industry, except those associated with normal vessel operations, are encompassed within the scope of the NPDES and will therefore require permits to discharge any effluents in the waters of the U.S.

In addition, under the Federal Water Pollution Control Act the Environmental Protection Agency has published for the "Offshore Segment of the Oil and Gas Extraction Point Source Category" Interim Final Rulemaking for effluent limitations and guidelines for existing sources to be achieved by the application of best practicable control technology currently available and proposed Effluent Limitations for Existing Sources, to be achieved by the application of best available technology economically achievable, Standards of Performance and Pretreatment Standards. Both of these Notices were published in the September 15, 1975 Federal Register (40 CFR 435). The Final Interim and Proposed Regulations set forth effluent limitations and guidelines for specific areas of sub-categories:

1. Subpart A - Near Offshore Subcategory. This Subcategory includes those offshore facilities within State waters engaged in the production, field exploration, drilling, well completions and well treatment of the oil and gas extraction industry.

2. Subpart B - Far Offshore Subcategory. This Subcategory includes those Offshore facilities with Federal Waters engaged in the production, field exploration, drilling, well completions and well treatment of the oil and gas extraction industry.

These subcategories were primarily based on considerations of (1) geographic location, (2) type of facility and (3) waste water characteristics and treatment ability.

The limitations published in the Final Interim regulations apply only to existing sources while the proposed regulations which will supercede the Interim regulations will apply both to existing as well as new point sources of oil and gas extraction. The comment period closed for the proposed regulations on October 15, 1975. A date has not been set for promulgation of the Final Regulations.

4. DEPARTMENT OF DEFENSE/CORPS OF ENGINEERS

Within the Department of Defense, several agencies operate upon or have jurisdiction over parts of the OCS and the superjacent waters. The Army

Corps of Engineers issues permits for any use of navigable waters, including dredging and filling, which may affect navigation. The Secretary of Defense has the power, with the approval of the President, to withdraw any area of the OCS from exploration and development if there is a national defense need, although he must "avoid interference with the exploration and exploitation of mineral resources of the Outer Continental Shelf ... to the maximum extent practical".

5. DEPARTMENT OF COMMERCE/NOAA

The Secretary of Commerce has the responsibility to administer The Federal Coastal Zone Management Act. This Act provides for Federal-state cooperation in planning for onshore and offshore development induced by OCS operations particularly with respect to the siting of pipelines, refineries and other facilities in the Coastal Zone.

Under the Marine Protection, Research and Sanctuaries Act (7) the Secretary of Commerce has the authority to designate marine sanctuaries as far seaward as the edge of the OCS for the preservation or restoration of recreational, ecological, and esthetic values. He may issue regulations applicable within such sanctuaries, and no permit or license may be granted for an activity within a sanctuary unless he verifies that it is consistent with the act and his regulations.

6. MARITIME ADMINISTRATION

In carrying out its responsibilities under the Title XI program, as described in Chapter I the Maritime Administration reviews technical plans and specifications to ensure that the vessels/rigs are in conformance with good shipbuilding practices and that these units comply with standards established by such regulatory bodies as U.S. Coast Guard, Environmental Protection Agency, American Bureau of Shipping, etc.

Periodic construction inspections are conducted to ascertain that these units are actually being constructed in accordance with the approved plans and specifications. Upon completion of the construction of the unit a MarAd representative attends the Sea Trial of the vessel/rig to again ensure that all regulatory requirements and good shipping practices have been carried out.

C. STATE JURISDICTION

Under the Submerged Land Act of 1953, ownership of the natural resources of lands "beneath navigable waters" of the United States is vested in the respective states. In general, the act extends "land beneath navigable waters" to 3 miles from the coast. Through subsequent litigation, however, Texas and Florida extended their resource ownership out to 9 miles within their historic boundaries (8) and in cases currently before the courts, several Atlantic states are attempting to establish ownership far beyond 9 miles.

If state claims for substantially extended jurisdiction are utlimately upheld, the entire system for regulating OCS development in such areas may have to be revised. State regulatory and resource management programs would have to be expanded to an unprecedented scale and mechanisms for interstate planning and coordination devised. In light of present uncertainties, it is unlikely that significant development of contested OCS areas could commence until the courts render a final decision (9) or until the Federal Government and concerned states negotiate an interim agreement.

Whatever the extent of their resource jurisdiction, the states and their political subdivisions possess important regulatory authorities within it and within related onshore areas. Through measures such as pollution control programs, land use restrictions, pipeline regulation, and zoning and building codes, states and localities can significantly shape OCS development and the construction and use of related nearshore and onshore facilities. Several states have recently enacted legislation providing for state review of development in "environmentally critical areas" and of the siting of key facilities, including powerplants and refineries.

State authority over OCS-related activities may well be strengthened under existing and proposed Federal legislation. The Federal Coastal Zone Management Act of 1972 (7) provides for state development of management programs for the coastal zone (extending 3 miles from the coast). Once the Secretary of Commerce approves a state program, no Federal license or permit may be granted for any activity (without territorial limitation) which affects the state coastal zone unless the state agrees that the activity is consistent with its management program. In addition, the Congress is currently considering broader land use legislation that would foster state planning and regulatory capabilities concerning major land use decisions beyond the coastal zone.

D. STATE-FEDERAL

An urgent need for effective Federal-state coordination follows from two related facts. First, as noted by Robert R. Jordon, State Geologist of Delaware, "geologic boundaries and exploration and production activities that are dictated by geological conditions do not respect political boundaries." (11) Effective regulation of OCS production and related activities therefore requires concerted action at all levels of government.

Second, OCS decisions at one level of government substantially impact upon the interest and activities at other levels. In particular, Federal decisions concerning the OCS will vitally affect what New York Attorney Louis J. Lefkowitz termed the states' "paramount" interest in protecting "fisheries, harbors, coastal wetlands, beaches and other natural resources from the devastating and lasting damage inflicted by oil spills," (12) as well as their economic and social interests.

To date over 90 percent of U.S. OCS oil production has occurred off the coast of a single state -- Louisiana. The possibility of significant production in other regions underscores the need to develop mechanisms for coordinating the legitimate interests and concerns of affected states.

As stated in the CEQ report (13) on the Outer Continental Shelf "... comprehensive planning is essential for rational and environmentally sound OCS development and state participation in such planning is an effective way to ensure adequate accommodation of state interests."

The Council on Environmental Quality recommended in its report (13) that the state coastal zone management agencies and concerned Federal agencies jointly participate in developing these portions of the plans. Before approving state coastal zone management programs, the Secretary of Commerce should require the state plans to consider refineries, transfer and conversion facilities, pipelines, and other development within the coastal zone related to OCS operations. Under the statute, the plans must provide "adequate consideration of the national interest involved in the siting of facilities necessary to meet requirements which are other than local in nature." At the same time they should provide adequate consideration of the full range of state interests in the coastal zone.

Because a decision to develop an OCS area may predetermine important decisions concerning uses of the contiguous coastal zone, states should

give high priority to completing their plans prior to leasing of OCS tracts for development. The Department of the Interior, in its leasing functions, and the state governments, in exercising their limited veto rights for activities inconsistent with their coastal zone programs, would implement the agreements reflected in the plans.

E. STATE AND REGIONAL REGULATIONS

As has been indicated previously in this Chapter, there are both national and international regulations which limit the flexibility a private operator has in constructing offshore drilling rigs. These are designed to maximize environmental and safety conditions, yet preserve the economic viability of the vessels vis-a-vis their foreign counterparts. Offshore drillings rigs are also subject to state and/or regional control in their construction and operation, within certain areas. Coastal states exercise almost exclusive jurisdiction over the territorial seas of the U.S. and the submerged land (43 U.S.C. Section 1311). While this jurisdiction is concurrent in areas of navigational safety and in some areas of environmental control, it is clear that if a State desires to limit the amount of drilling that may be conducted within its jurisdiction, a permit system may be set up somewhat similar to the leasing system for the Outer Continental Shelf (see Section IV-B). Further, as part of its coastal management programs, established under the Coastal Zone Management Act of 1972, particular areas within a state's jurisdiction can be set forth as non-available for drilling operations, if such a decision is based on a rational and balanced decision-making process. Already, Delaware has enacted legislation prohibiting the construction of offshore deepwater ports within its jurisdiction.

Regional control can be exercised through regional recommendations, which are implemented as laws or regulations by the various member states.

As an indication of a states power to regulate with respect to pollution control, a recent case before the Supreme Court found that the provisions of the Federal Water Pollution Control Act of 1972 were not exclusive or preemptive on the States, and that State regulations going beyond the Act's provisions could be enforced within the State's jurisdiction (*Askew v. American Waterways Operators*, 1973, 411 U.S. 325, 93 ct. 1590 (1973).

F. NATIONAL CONTINGENCY PLAN FOR CONTROLLING OIL SPILLS

The National Oil and Hazardous Substances Pollution Contingency Plan developed in compliance with the Federal Water Pollution Control Act

provides a mechanism for coordinating the response to an oil discharge in U.S. waters, shoreface, or shelf-bottom. The objectives of this plan are to provide for efficient, coordinated, and effective action to minimize damage from oil, including containment, disposal, and removal. The plan provides for:

- assignment of duties and responsibility among Federal departments and agencies in coordination with State and local agencies;

- identification, procurement, maintenance and storage of equipment and supplies;

- establishment or designation of a strike force to provide necessary services to carry out the plan and establishment, at major ports, of trained and equipped emergency task forces;

- a system of surveillance and reporting designed to insure the earliest possible notice of discharge of oil and hazardous substances to the appropriate Federal agency;

- establishment of a national center to provide coordination and direction for operation in carrying out the plan;

- procedures and techniques to be employed in identifying, containing, dispersing, and removing oil and hazardous substances;

- a schedule, prepared in cooperation with the States, identifying dispersants and other chemicals, if any, that may be used in carrying out the plan; and

- a system whereby the State or States affected by a discharge may be reimbursed for reasonable costs incurred in the removal of such discharge.

The EPA and the U.S. Coast Guard furnish the Chairman and Vice Chairman of the National Response Team (NRT). The U.S. Coast Guard supplies support and expertise in the domestic/international fields of port safety and and security, marine law enforcement, navigation, construction, manning operations, and safety of vessels and marine facilities. The Department of Commerce is a Primary member of the NRT and provides support through NOAA to the National and Regional Response Teams with respect to marine environmental data living marine resources current and predicted meteorological, hydrological and oceanographical conditions for the high seas, coastal, and inland waters and maps and charts, including tides and currents

for coastal and territorial waters and the Great Lakes. When requested by the NRT, MarAd will provide advice on the design, construction and operation of merchant ships.

Any response required as a result of operations conducted under the Outer Continental Shelf Lands Act are carried out in accordance with a Memorandum of Understanding between the Department of Transportation and the Department of the Interior.

The Council on Environmental Quality is responsible for the preparation, publication, and revision of the National Contingency Plan. The current National Contingency Plan now in force has been revised as of February 10, 1975.

G. ABS RULES FOR BUILDING AND CLASSING OFFSHORE MOBILE DRILLING UNITS, 1973

The American Bureau of Shipping's "Rules for Building and Classing Offshore Mobile Drilling Units" was first published in 1968 as a result of the combined efforts of industry experts, the U.S. Coast Guard, and the Bureau's Technical Staff. These Rules were revised and updated in 1973 to reflect new design innovations, data gathered from service experience, and the expansion of offshore drilling exploration into areas of new and varied environmental conditions.

These Rules focus on the three basic categories of mobile drilling units commonly in use at present:

the surface type (ship and barge)
the self elevating type (jack-up)
the column stabilized type (submersible and semi-submersible)

Each design possesses its own unique design requirements. In addition, the Rules provide for the calssification of units of a novel configuration not specifically falling into one of these categories, or possibly combining the characteristics of two or more of the above types. In this case, all the applicable requirements of the Rules would be utilized, in conjunction with the best engineering practice currently available.

The ABS Rules for drilling units are intended to apply to the hull structure, the main propulsion machinery, and the essential auxiliary equipment

necessary for the safe operation of the unit. Each design is reviewed by Surveyors of the Bureau's Technical Staff for compliance with requirements of the Rules with regard to:

- Structural adequacy of the unit for the design parameters specified by the designer.
- Use of appropriate materials and welding techniques.
- Intact and damage stability.
- Essential machinery, piping, and electrical systems.
- Emergency mooring equipment.
- Essential safety features such as fire-fighting equipment life-saving appliances, guard rails, alarms, and the ventilation and electrical installations in restricted areas.

In addition, an operating booklet is required to be prepared for each unit as a condition of Classification and to the satisfaction of the Bureau. The booklet is to contain the following information, as applicable to the particular unit.

- General description of the unit, including experiment results, light ship data, etc.
- Pertinent data for each operating condition, including design loading, wave height, bottom condition, draft, etc.
- General arrangement showing watertight compartments, closures, vents, permanent ballast, allowable deck loadings, etc.
- Hydrostatic curves or equivalents.
- Capacity plan showing capacities of tanks, centers of gravity free surface corrections, etc.
- Instructions for operation of the unit including adverse weather, changing modes of operation, any inherent limitations of operations, etc.

- Stability information in the form of maximum KG versus draft curve or other suitable parameters based upon compliance with the required intact and damaged stability criteria.

- Representative examples of loading conditions for each mode of operation together with means for evaluation of other loading conditions.

It is required that Surveyors to the Bureau verify compliance to material specifications and attend the fabrication of the unit's essential equipment at the place of manufacture. A Surveyor will also attend the construction of the unit and the installation of its equipment.

To maintain the drilling unit in classification after construction, periodic surveys are required to ensure that the unit is kept in good operating condition. This examination of the unit's soundness also provides a valuable feedback mechanism as to its performance while in service.

It should be noted that systems and equipment used solely for the performance of drilling operations are not considered as part of the classification, other than the effect they have on the loading of the structure. An exception to this pertains to requirements concerning the elimination of ignition sources and the ventilation in restricted areas where an explosive atmosphere may exist due to the nature of the operation.

Although the Rules, as originally promulgated, were intended to apply primarily to offshore mobile drilling units, there has recently been a trend towards utilizing the advantageous characteristics of these vessels in the design of structures of varied functions, i.e., oil production and power generating facilities, etc. Due to similarities in structural configuration and mode of operation, these structures can be reviewed in accordance with the applicable requirements of the ABS "Rules for Building and Classing Offshore Mobile Drilling Units."

Full compliance to the standards set forth in these Rules should ensure a structurally sound and seaworthy base structure. This, of course, is an essential prerequisite to minimizing the effect of offshore exploration and exploitation upon the environment.

It should be borne in mind that requirements in excess of or additional to those specified in the Rules of the American Bureau of Shipping, may be specified by International Organizations, the Government Authorities

under which the vessel is registered, and those having jurisdiction over the area in which the vessel is to operate. In this regard, the International Association of Classification Societies is currently developing unified requirements for mobile drilling units, including strength and design parameters, requirements for machinery and electrical installations and stability. It is hoped that drilling units built in accordance with such requirements would be acceptable to many governments for operation in waters under their jurisdiction, with a minimum of modification to suit individual governmental requirements when changing from one location to another.

H. OFFSHORE OPERATORS COMMITTEE

History has recorded that drilling for oil and gas did not have its beginning in offshore waters. However, the petroleum industry has made remarkable technical progress since 1897 when the first offshore platform was erected off Santa Barbara. In 1945 the first offshore well in the Gulf of Mexico was drilled from a structure made of wood, using a converted land rig supported by a tender.

The oil operators did not take long to realize the tremendous potential that offshore waters offered. In 1948, the Offshore Operators Committee was formed; however, "By Laws" were not written until 1952. This committee was open to any company who was a lease holder in the Gulf of Mexico. The purpose of the committee was to exchange information and to solve common problems encountered in offshore drilling and producing. The "By Laws" have been amended twice since the original writing. One of these amendments opened the committee doors for the associate member, namely those involved in offshore drilling in the Gulf of Mexico. This group includes the drilling contractor, the service company, the supplier, and others involved in this offshore activity. The Offshore Operators Committee recognized that these associate members were vitally concerned and involved; that they have vast amounts of technical knowledge and operating expertise to offer the industry.

The Offshore Committee realized that one of its primary tasks was to prepare a "Safe Practice Manual." This "Manual of Safe Practices in Offshore Operations" was the joint effort on the part of members of the International Association of Drilling Contractors, the Offshore Operators Committee, the National Offshore Operations Industry Advisory Committee, the Commandant U.S. Coast Guard, and the Western Oil & Gas Association.

The latest revision (second) is dated January 1, 1972. It should not be implied that prior to going offshore for the search for oil and gas the drilling industry did not provide collective ways for the education of its employees. From the early days, it did not take the industry long to recognize the need for education at all levels. The drilling industry developed a comprehensive program for training its personnel. Assistance in this training program was given by universities,' trade publications and others.

REFERENCES TO CHAPTER IV

1. U.N. DOC./A/CONF. 13/L. 55, June 10, 1965.

2. 43 U.S.C. § 1301-15 (1953).

3. 43 U.S.C. §§ 1331 et seq.

4. 42 U.S.C. §§ 4321-4347 (1969)

5. P.L. 92-500.

6. 32 CFR § 252 4 (a) and (e).

7. P.L. 92-532.

8. See United States v. Louisiana; 363 U.S. 1 (1960), rehearing denied, 364 U.S. 856 (1960); United States v. Florida, 363 U.S. 21 (1960).

9. Mineola public hearings, infra note 11.

10. See University of Oklahoma Technology Assessment Group, Energy Under the Oceans (Norman: University of Oklahoma Press, 1973), p. 209.

11. Statement at public hearings conducted by the Council on Environmental Quality, Ocean City, October 12, 1973.

12. Statement at public hearings conducted by the Council on Environmental Quality, Mineola, Long Island, N.Y., October 12, 1973.

13. Statement at public hearings conducted by the Council on Environmental Quality, "OCS Oil and Gas - An Environmental Assessment."

CHAPTER V

ALTERNATIVES TO THE TITLE XI OFFSHORE OIL AND GAS DRILLING PROGRAM

A. ALTERNATIVES TO OFFSHORE DEVELOPMENT IN GENERAL

The foundation for the MarAd Program is continuation and acceleration of the government's program for leasing offshore lands for development. Offshore oil and gas rights are controlled primarily by the Federal government and to a lesser extent by the states. If the offshore leasing program were terminated there would be little demand for program vessels. The present governmental policy is to accelerate leasing as part of the nation's program to increase domestic energy sources. This policy has stimulated a demand for offshore drilling and service vessels to which the Maritime Administration has responded.

The government could review the decisions it has taken to encourage the development of offshore resources and develop other alternatives of energy. While these are not alternatives to the MarAd Program, they are alternatives to the larger program which is supported to some extent by this agency's program. These alternatives include some near-term alternatives such as:

Increased conventional onshore production of oil and gas
Development of Synthetic Sources of oil and gas
Importation of Oil and Gas
Development of Coal, Nuclear Power, and Hydroelectric Power.

Other less conventional and longer term alternatives could include:

Oil shale and tar sand development
Solar energy
Wind energy
Tidal energy
Geothermal energy and other more sophisticated sources of power.

Finally, our nation's energy problem could be solved through conservation of energy or by using a combination of the above mentioned approaches. As indicated, these alternatives are not available to the Maritime Administration and, for the most part, would require extensive and far-reaching

actions on the part of the White House and the Congress. The Department of the Interior analysis entitled, "Energy Alternatives and their Related Environmental Impacts," [1/] examines all of these alternatives as follows:

1. Energy Conservation

Vigorous energy conservation is an alternative that warrants serious consideration. The Project Independence Report of the Federal Energy Administration claims that energy conservation aline can reduce energy demand growth of 0.7 to 1.2 percent depending on the world price of oil. Aside from these savings, it is now widely recognized that wasteful consumption habits impose social costs such as pollution and an inequitable distribution of fuel, that can no longer be afforded.

The residential and commercial sectors of the economy are often characterized as inefficient energy consumers. Inadequate insulation, inefficient heating and cooling systems, poorly designed applicance and excessive lighting are often noticed in these sectors. To achieve reductions in consumption beyond those induced by fuel price increases could require new standards on products and buildings, and/or subsidies and incentives. These incentives could impose standards for improved thermal efficiency in existing homes and offices and minimum thermal standards for new homes and offices.

Excessive consumption is also evident in the industrial sector where energy inefficient work schedules, poorly maintained equipment, use of equipment with extremely low heat transfer efficiencies, and failure to recycle heat and waste materials are all common place. Estimated energy savings of between 10 and 30 percent may be available in this sector of the economy.

Transportation of people and goods accounts for approximately 25 percent of nationwide energy use. Energy inefficiency in the transportation sector varies directly with automobile usage. Automobiles, which account for 90 percent of all passenger movement in the nation, use more than twice as much energy per passenger mile as buses. Moreover, the average car carries only 1.3 passengers. Using short and mid-term conservation measures such as consumer education, lower speed limits rate and service improvements on public transit and rail freight transit, energy savings of 15-25 percent might be possible.

Other policies to encourage fuel conservation in transportation could include standards for more efficient new autos and incentives to reduce miles traveled. An important new development in the fuel economy area could

[1/] Abstracted from DOI Final Environmental Impact Statement - Proposed 1975 Outer Continental Shelf Oil and Gas Lease Sale Offshore Central Gulf OCS Sale No. 38.

be the modifications of the standard internal combustion engine developed by two Vermont engineers. Their modified engine may be able to improve fuel economy of automobiles by an average of 50 percent with no loss in power.

Significant energy savings are clearly possible through accelerated conservation efforts. The Project Independence Report estimates that conservation alone could result in a 2.2 million barrel per day reduction in petroleum demand by 1985. These savings will be necessary in order to achieve the goals of energy self-sufficiency.

2. Conventional Oil Supplies

Large quantities of oil still remain in the United States. The U.S. Geological Survey estimates that undiscovered recoverable resources of 135-270 billion barrels of oil are located onshore. This figure, however, is an estimate of the nation's total petroleum resource base and is not an indication of the oil supply that will be available for future consumption. The term "proved reserves" refers to those volumes of petroleum liquids that are known from drilling and are economically producible at current prices with current levels of technology. The Project Independence Report uses the American Petroleum Institute's latest (January 1, 1974) annual figure on proved reserves, 35.3 billion barrels. In addition to these reserves, T.A. Hendricks, W.C. Mallory, and associates of the USGS claim that an additional 25 to 45 billion barrels of petroleum liquids could be added to proved reserves through extensions, revisions, and discoveries of new pools in known fields.

Despite the magnitude of the proved reserve estimate, domestic oil production is almost certain to continue its decline from the peak production rate attained in 1970. All of the 12 oil production forecasts discussed in the Project Independence Blue print claimed that, in the next few years, the petroleum production decline would continue in the United States. Most of these same forecasts predict increasing domestic production by the late 1970's but only under the most favorable conditions in terms of prices, regulations, and environmental constraints.

3. Increased Domestic Gas Supplies

a. Deregulation of the Wellhead Price of Natural Gas

The regulated price of natural gas has often been cited as an important cause of the meager supply of domestic gas. Eliminating the price ceiling on natural gas may have an inflationary impact though it would encourage

development of native gas reserves and thus help reduce foreign dependence. With regard to the inflation issue, the lack of natural gas supplies causes increased consumption of expensive alternatives; the average price of natural gas after deregulation may well be less than these alternative supplies. In any case, domestic supplies of natural gas have to exist and have to be accessible. The OCS is believed to be one of the most propitious areas for natural gas development.

b. Nuclear Stimulation of Gas Formations

Nuclear stimulation, an experimental method of manufacturing low permeability gas reservoirs otherwise incapable of sustaining commercial production, has the potential to add materially to U.S. recoverable gas reserves. The Atomic Energy Commission is conducting research and development of nuclear explosives and techniques for utilizing the effects of miltiple nuclear explosives to recover natural gas locked in tight geologic formations. Such gas cannot now be produced economically by conventional methods. Most reserves which are amenable to nuclear stimulation lie in thick, deep reservoirs of very low natural permeability located in the Rocky Mountain area.

The Federal Power Commission has estimated that total yearly gas production by 1985 from the Uinta, Piceance, and Green River Basin fields using nuclear stimulation from 110 to 200 wells would be 812 to 1,939 billion cubic feet. [1/]

Environmental effects of nuclear stimulation to increase natural gas production from tight reservoirs are related to radioactivity and seismic disturbance, both of which concern the surface or subsurface, leaving atmospheric contamination or disturbance unlikely. The depth of the gas formations of interest throughout the Rocky Mountain area is such that the probability of releasing any appreciable amounts of radiation to the atmosphere at detonation time is considered negligible. Most of the radioactivity produced by the explosives will remain underground, trapped in the resolidified rock near the bottom of the chimney or attached to the rock surfaces in the chimney.

Project design would consider mobile waters and assure that chimneys remain isolated from them. Methods are being developed to dispose of water produced with the gas and containing low levels of tritium. The potential environmental impacts of nuclear stimulation of a single well or several wells in small geographic areas have been evaluated by the AEC,

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1/ Federal Power Commission, April 1973, Natural Gas Technology Task Force for the Technical Advisory Committee of the Natural Gas Survey by the Federal Power Commission, p. II-7.

for example, for the Rio Blanco and Wagon Wheel Projects. The impacts of more extensive development depends on the frequency and size of explosives and changes in the local environment. The possibility that residual stress from a number of detonations might accumulate and present an earthquake stimulation hazard requires continued appraisal during future nuclear stimulation projects.

4. Coal

Coal is the most abundant energy resource in the United States. Coal deposits underlying nearly 460,000 square miles in 37 states constitute one-quarter of the known world supply and account for 80 percent of our proven fuel reserves. Proven reserves of coal contain 125 times the energy consumed in 1970.

In many uses, coal is an imperfect substitute for oil or natural gas. In many cases, coal use is restricted by government constraints, limited availability of low sulfur deposits, inadequate mining, conversion and pollution abatement technology, and the hazardous environmental impacts associated with coal extraction and coal-generated electricity. Coal production is also threatened by a unique set of labor problems associated with mining and new strict standards for coal mine safety.

As with other extractable hydrocarbons, the quantity of available coal is a function of coal's market price. At the 1972 price, for instance, only 12 percent of the total resource could be considered recoverable. At double this price, the amount of recoverable coal would be equivalent to 2 1/2 times the anticipated aggregate energy demand for the U.S. between 1960 and 2000. Current increases in the market price for coal are making more of the resource base available for domestic consumption.

Public concern over dangerous underground mine conditions inspired the Federal Coal Mining Health and Safety Act of 1969. This legislation has improved underground mining conditions and therefore has reduced the occupational hazards confronted by many coal mines. This Act has also increased the costs of underground coal mining - an important side effect since most of the nation's coal reserves can be recovered only by underground mining. Additionally, the Mining Health and Safety Act has added to strip mining's long established competitive advantage over underground mining since strip mining is far less hazardous than underground mining and is thus subject to fewer of the Act's provisions and regulations.

The advent of new, strict air quality regulations has diminished the attractiveness of coal. One-third of the domestic coal reserve does not meet the low-sulfur requirement. The two-thirds of this reserve that is environmentally acceptable is located mainly in the Rocky Mountain States and is generally of lower Btu value than eastern coals. The cost of transporting Rocky Mountain coal to population centers of the eastern or western United States adds significantly to its price, putting much of it at a competitive disadvantage with other energy sources.

5. Synthetic Sources of Oil and Gas

a.. Oil Shale

The nation's vast oil shale resources have not in the past been considered as part of the domestic energy supply because of the ready availability of low cost oil and gas. Current needs, however, may necessitate rapid exploration of this fossil fuel.

Oil shale can be processed after its extraction using a surface technique, or, in place processing can be conducted. As with coal, oil shale may be extracted using underground or surface (i. e., strip mining) mining techniques.

The Green River Formation covering parts of Colorado, Utah and Wyoming contains the most abundant concentration of oil shale in the nation. Approximately 600 billion barrels of oil are believed to be deposited in this location.

Oil shale development does pose serious environmental risks however. With surface or conventional underground mining, it is very difficult to dispose of the huge quantities of spent shale which occupy a larger volume than before the oil was extracted. Inducing revegetation in an area where oil shale has been developed is a difficult task often taking in excess of ten years. The in-place processing alternative avoids many of these environmental hazards but disturbance of underground aquifers and contamination of ground waters are side-effects of both development techniques.

Commercial development of the Green River Formation would require significant quantities of water. Yet the Colorado Utah-Wyoming area is low on water supplies. Hence, another obstacle to oil shale development is posed.

The list of impediments does not end here. The Green River Formation is sparsely settled. Oil shale development will cause major changes in existing land uses and thus have social and economic repurcussions in an

area traditionally devoid of a large scale industry. In that the Colorado oil shale lands have some of the largest migratory deer and elk herds in the world, impacts on the regional wildlife are expected.

Roads, mining plant sites, waste disposal areas, and utility line corridors will disrupt the land's vegetative cover and intensify sediment loads in the area's streams. Disposing the hugh volume of waste water containing dissolved inorganic and organic compounds without degrading natural ground waters will severely strain the region's already scarce water resources. Oil shale mining will raise noise pollution levels and the attendant particulate emissions will lower ambient air quality.

b. Synthetic Natural Gas and Oil

Liquifying and gasifying coal in commercial quantities is another target of current energy research. Synthetic oil is the end product of coal liquefaction while gasification produces synthetic natural gas. Of the two methods, researchers have devoted more effort to gasification because of the high cost encountered in producing synthetic oil. Natural gas can also be synthesized from petroleum. Such gas has been produced commercially in Europe and some forty plants are planned for the United States.

High costs and the elementary level of technology have impeded synthetic natural gas and oil development. Pilot plants have been operating domestically but commercial production levels have not been achieved. The role of synthetic natural gas and oil in the nation's future energy supply will depend on environmental standards, the effects of new health and safety standards on coal mining, and the availability of water.

Several environmental problems are associated with coal gasification and liquefaction. The ecological side-effects of extracting coal is a major problem because coal is the raw material for either process. Moreover, these processes cause water, air, and noise pollution.

According to Dr. Thomas A. Henri (Bureau of Mines, USDI), a typical coal gasification plant will produce 250 million cf/d of pipeline gas, consume six to 10 million tons of coal annually, use about 6,000 gallons of water per minute, and have capital costs (including coal mine development) of over $400 million.

6. Hydroelectric Power

The energy captured from falling water is termed hydropower. This falling water, regulated and controlled by human technology, is used to drive turbines and thus produce electrical energy. The engineering problems of converting hydropower to electrical energy were mastered early in the development of electrical generation technology and many of the major hydroelectric sites operating today were developed in the early 1950's. The Pacific Northwest region and California are served by hydroelectric power to a greater extent than most other regions of the nation because of the wet climate and favorable topography.

Theorectically, increased domestic reliance on hydropower is currently possible. The undeveloped potential for hydroelectric generation in the lower 48 States alone is about 94,000 MW (FPC, 1972). If that potential were developed fully then hydropower could supply nearly 8 percent of the current domestic energy demand, (FPC, 1972). Yet most energy supply forecasts envision a relative decline in hydropower's future contribution to domestic energy needs. This paradox stems from the following conditions:

1. The sites with the greatest productive capacity and the lowest development costs have already been exploited.

2. Hydroelectric power imposes substantial land use conflicts and environmental side-effects.

3. The dams and reservoirs required by hydropower development have exorbitant capital costs.

4. The amount of energy that can be produced via hydropower varies with the seasons.

5. Manipulation of reservoir storage capacity is constrained by water use and flood control considerations.

As a consequence of the above factors, an important future application will be "pumped storage" hydroelectric projects. Pumped storage uses the excess energy generated by nuclear or fossil fuel plants to pump water from a lower reservoir to a higher one. During periods of peak electricity use, the previously pumped water is allowed to fall from the upper reservoir thus producing the electricity required during the period of elevated demand. Pumped storage has at least 2 advantages:

1. It utilizes the excess energy of conventional electricity plants and thus improves their efficiency.

2. It makes available the most economical supply of peak quantities of electricity during periods of accelerated demand.

Construction of a hydroelectric dam represents an irreversible commitment of the land resources beneath the dam and lake. Flooding eliminates wildlife habitat and prevents other uses such as agriculture, mining, and free-flowing river recreation.

Hydroelectric projects do not consume fuel and do not cause air pollution. However, use of streams for power may displace recreational and other uses. Water released from reservoirs during summer months may change ambient water temperature and lower the oxygen content of the river downstream, adversely affecting indigenous fish. Fluctuating reservoir releases during peak load operation may also adversely affect fisheries and downstream recreation.

Fish may die from gas-bubble disease if exposed to nitrogen supersaturated water. Nitrogen supersaturation results at a dam when excess water escapes from the draining reservoir. High nitrogen levels in the Columbia and Snake Rivers pose a threat to the salmon and steelhead resources of these rivers.

7. <u>Nuclear Power</u>

The predominant nuclear system used in the U.S. is the uranium dioxide fueled, light water moderated and cooled nuclear power plant. Research and development is being directed toward other types of reactors, notably the breeder reactor and fusion reactors.

Installed nuclear capacity, as of June 1974, was 28,000 MW. At that time, nuclear power generated about 6 percent of the Nation's electricity. However, about half of the electric power capacity now under construction is nuclear powered. Nuclear power development has encountered delays in licensing and siting, environmental constraints, and manufacturing and technical problems. Future capacity will be influenced by the availability of plant sites, plant licensing considerations, environmental factors, nuclear fuel costs, rate of development of the breeder and fusion reactors, and capital costs. In order to meet future uranium requirements, an increase in exploratory drilling activity will be necessary.

Although nuclear plants do not emit particulates or gaseous pollutants from combustion, serious environmental problems arise. Some radioactivity in the form of radiation, airborne radioactivity, and radioactive liquids, is released to the environment. Although the amount released is very small and potential exposure has been shown to be less than the average background level of natural radiation, special precautions are in effect to control these emissions. The possible release of radioactivity as a result of an accident must be anticipated and the plants are designed to withstand a design basis accident. This is defined as the worst malfunction considered to have a probability of occurrence high enough to warrent corrective action. The probability of a serious nuclear accident occurring in any one of the nuclear generators in an existing generator population is believed to exceed the risk associated with a single nuclear plant when evaluated separately. A report issued recently by the AEC discusses the probability of accident risks in U.S. commercial nuclear power plants (WASH-1400).

Nuclear plants use essentially the same cooling process as fossil-fuel plants and thus share the problem of heat dissipation from cooling water. However, light-water reactors require larger amounts of cooling water and discharge greater amounts of waste heat to the water than comparably sized fossil-fuel plants. The effects of thermal discharges may be beneficial in some cases. Adverse effects can be mitigated by use of cooling ponds or cooling towers.

Low level radioactive wastes from normal operation of a nuclear plant must be collected, placed in protective containers, and shipped to a storage site and buried. High level wastes remaining after fuel processing are concentrated and stored in solution. Presently these are being stored in the fuel reprocessing plants and in the future will be solidified and shipped to a Federal repository for storage.

8. Solar Energy

Energy from the sun can be used to heat or cool individual buildings and to generate electricity. In the 1940's and 1950's, prior to the availability of low cost natural gas, firms selling solar water heaters did a booming business in California and Florida. Commercially installed solar heating and cooling in homes will be in use in many parts of the nation by 1985 and will be common by 1993. Moreover, intensifying current research and development could hasten these dates by five years. Solar energy may eventually supply 35 to 50 percent of the nearly 20 percent of the nation's

energy that is now devoted to space conditioning, thus reducing significantly the peak electricity demands of the summer months.

Congressional interest in solar energy research has recently been aroused. The Solar Heating and Cooling Demonstration Act of 1974 legislates a $60 million demonstration program aimed at proving the commercial feasibility of solar heating of buildings and homes by 1977 and of combined solar heating and cooling systems for those structures by 1979. Although fuel costs for backup systems and maintenance costs for solar units are miniscule when compared with operating costs of conventional heating and cooling systems, the initial or "fixed" costs of solar units are too high to make them immediately competitive. The typical solar heating system for a home costs $5,000 - $6,000 (including costs of a standby conventional furnace) compared to $1,000 - $2,000 for a conventional fossil-fuel home heating unit. However, the rising cost of the gas and oil needed by the conventional heaters means that the initial difference in fixed costs will quickly be overshadowed by the solar systems' lack of fuel costs. Therefore, though more costly at first, the solar unit will be the economical alternative over time.

The full potential of solar energy can be realized only after large-scale generation of electricity using solar energy becomes technically and economically feasible. For this reason the Government has requested $33 million for solar electric programs in fiscal 1975 - almost $26 million more than the fiscal 1974 appropriation. A number of technical and engineering problems now prevent commercialization of solar steam-electric plants though pilot projects are well underway. It is estimated that by 1985 solar electricity will provide 0.3 - 0.6 quadrillion Btu's of space heating annually.

Solar-electric energy does have a few disadvantageous aspects -- high capital costs, expensive maintenance of solar collectors, thermal waste disposal, and distortion of local thermal balances being the most prominent.

Yet the engineering and technical problems that have not yet been solved are considerably less difficult than those for fission breeders or fusion reactors. The accelerating real costs of fossil fuel plus the serious implications of substantial foreign dependence will continue to increase the attractiveness of the solar energy option. Finally, the environmental impacts of solar energy are significantly less severe than those imposed by the traditional energy sources.

Solar energy cannot substitute for petroleum in all uses, transportation and petrochemicals being the most obvious illustrations. However, as solar energy is used with increasing frequency for heating and electricity generating purposes, oil and gas supplies previously devoted to heating and electricity will be channelled to the petrochemical and transportation industries. Thus solar energy's somewhat restricted applicability, does not constitute a significant disadvantage.

9. Energy Imports

a. Oil

Increasing this nation's reliance on foreign energy supplies is another alternative to offshore development. Such an action would, however, entail a very high cost. U.S. imports of petroleum in 1973 amounted to 2.264 billion barrels. At current world oil prices, this quantity of oil would carry a $23 billion price tag.

Studies conducted by the Department of the Interior show that oil produced on the OCS of the United States is much cheaper than the foreign alternative. Extraction plus transportation costs for OCS oil are anywhere from $6.50 - $8.00 per barrel less than the world oil price.

The table on the following page shows projected patterns of import reliance for the next ten years. The sources of oil imports in 1970 is also presented as a comparison. These projections assume an energy growth rate of about 3.5% plus an expanded role for the OCS in domestic production.

U.S. PETROLEUM SUPPLY-DEMAND AND SOURCE OF OIL IMPORTS
(Thousand Barrels per Day)

	1970	1975	1980	1985
Domestic Demand	14,728	18,400	22,790	26,885
U.S. Production	11,328	10,800	10,500	9,725
North Slope Crude	-	-	1,500	2,000
Total Imports	3,418	7,600	10,790	15,160
Source of Imports:				
From Canada (pipeline)	766	1,300	1,800	2,200
Total Waterboine Imports	2,652	6,300	8,990	12,960
From Western Hemisphere	2,091	3,200	3,280	4,106
From Europe	177	200	300	400
Total in small tanker	2,268	3,400	3,580	4,506
From Middle East	185	2,325	4,610	7,354
From S.E. Asia	72	175	100	100
From Africa	127	400	700	1,000
Possible for large tankers	384	2,900	5,410	8,454

If the above projections do prove accurate and if current world oil prices are maintained through 1985 then our oil bill will be about $150 million daily or about $55 billion annually. This amount will increase if imports are substituted for domestic OCS production.

Importing high cost foreign oil has been singled out as contributing factor to the current inflationary cycle. In addition, increased reliance on foreign oil causes a tangible deterioration in the nation's balance of payments thus weakening the nation's international trade position.

It should also be mentioned that imports carry their own set of adverse environmental impacts. Spills from tankers carrying imported oil can result from intentional discharges, accidental discharges, tanker casualties,

and tanker collisions. A study of oil pollution in domestic waters during the years 1969-1970 shows that tankers accounted for about 28% of the polluting oil.

b. Natural Gas

Pipeline imports of natural gas into the U.S. have come mainly from Canada and Mexico. However, significant expansion of natural gas imports from these countries is questionable because of increasing domestic demand, both current and future, within Canada and Mexico. If new Canadian discoveries result in large reserve additions, surpluses may become available for export to the U.S.

The growing shortage of domestic gas has encouraged projects to import liquefied natural gas (LNG) under long term contract. Large scale shipping of LNG is a relatively new industry and the U.S. does not yet have facilities for receiving base load shipments. Several LNG projects are now under consideration on the Pacific, Atlantic, and Gulf coasts. However, the Middle East oil cutback has raised questions concerning the security of foreign, especially Algerian, sources of LNG. The complexity of and length of time involved in implementing these proposals has been increased by the need for negotiating preliminary contracts, securing the approval of the Federal Power Commission and the exporting country, and making adequate provision for environmental and safety concerns in the proposed U.S. facilities.

The chief source of possible increased pipeline natural gas imports is Canada. The Canadian policy has been to restrict the level of natural gas exports in order to build a large domestic reserve. Unless this policy changes or significant new Canadian discoveries are made, it is unlikely that more gas would be available to import.

LNG import levels will depend on how soon this industry can be introduced into the U.S. The question of security of foreign LNG supplies has caused re-evaluation of these projects.

The environmental impacts of LNG imports arise from tankers; terminal, transfer, and regasification facilities; and transportation of the gas. The primary hazard of handling LNG is the possibility of a fire or explosion during transportation, transfer, or storage.

Receiving and regasification facilities will require prime shoreline locations and dredging of channels. Regasification of LNG will release few pollutants to the air or water.

LNG imports will influence the U.S. balance of payments. This impact will depend on the origin and purchase price of the LNG, the source of the capital, and the country (U.S. or foreign) in which equipment is purchased and LNG tankers are built.

10. Other Energy Sources

The high costs and rapidly shrinking reserves of the traditional energy fuels have encouraged research into new and different sources for potential energy. As the cost of traditional fuels continues to grow at accelerating rates, demand for, and eventual substitution by alternate energy forms will occur. Some of these alternate sources have been known for decades but high costs and technical problems have prevented their widespread use.

Environmental impacts of these alternatives are sometimes difficult to assess, especially if a great amount of research and development remains to be completed before operational scale systems can be developed, tested, and evaluated for production and application.

For the following listed alternatives, the date of commercial availability will depend on the cost of the traditional energy fuels, the level of Federally-subsidized research, and the probability of encountering insurmountable engineering and technical problems. Thus some of these energy sources could be installed within the current decade, while others may prove never to be feasible.

a. Possible significant energy contribution before 1985 [1/]

Energy forms	Primary limitations	Secondary limitations
Geothermal energy	Resources	Economics
Tar sands	Resources	Economics

1/ After: New Energy Forms Task Group 1971-1985, National Petroleum Council Committee on U.S. Energy Outlook, 1972.

b. Improbable significant contributions before 1985

Energy forms	Primary limitations	Secondary limitations
Hydrogen	Economics	Technology
Biological (agricultural & wastes)	Economics	Resources
Solar	Technology	Economics
Tidal	Resources	Economics
Wind	Resources	Economics
Energy Conversion Devices		
Fuel cells	Technology	Economics
Thermonics	Technology	Economics
Thermoelectric	Technology	Economics
Mangetohydrodynamics	Technology	Economics

Federal energy research and development funding has expanded significantly in the last few years. President Nixon announced in his Energy Message of January 23, 1974, that Federal commitment for direct energy research and development will be increased to $1.8 billion in FY 75. The table below shows the FY 74 funds for different areas of research and the preliminary FY 75 request for funds.

FEDERAL ENERGY R&D FUNDING
($ million)

Direct Programs	FY 74	FY 75	Agency*
Conservation	65.0	128.6	
a. End use (residential & commercial	15.0	27.9	DOI, other
b. Improved efficiency (transmission)	5.0	18.8	AEC, DOI, NSF
c. Improved efficiency (conversion)	14.9	29.8	AEC, DOI, NSF
d. Improved efficiency (storage)	2.9	6.4	AEC, NSF
e. Automotive	14.2	23.7	AEC, EPA, NSF, DOT
f. Other transportation	13.0	22.0	DOT, DOC
Oil, gas, and shale	19.1	41.8	
a. Production	3.0	17.0	DOI
b. Resource assessment	5.0	13.0	DOI, NSF
c. Oil shale	2.3	3.0	DOI
d. Related programs	8.8	8.7	AEC, DOI

Coal	164.4	415.5	
a. Mining	7.5	55.0	DOI
b. Mining, health & safety	27.0	27.7	DOI
c. Direct combustion	15.9	36.2	DOI, NSF
d. Liquefaction	45.5	108.5	DOI, NSF
e. Gasification (high BTU)**	33.0	65.3	DOI, NSF, AEC
f. Gasification (low BTU)	21.3	50.7	DOI, NSF
g. Synthetic fuels pioneer program		42.1	DOI 1/
h. Resource assessment	1.2	1.9	DOI
i. Other (incl. common technology)	11.7	28.1	DOI
Environmental Control	65.5	178.5	
a. Near term SO_x	39.9	82.0	EPA, DOI
b. Advanced SO_x	4.0	12.0	EPA
c. Other fossil fuel pollutants (incl. NO_x, particulates)	13.1	57.0	EPA
d. Thermal pollution	1.5	18.5	EPA, AEC
e. Automotive emissions	7.0	9.0	EPA
Nuclear fission	530.5	724.7	AEC 1/
a. LMFBR	337.3	473.4	
b. Other breeders (GCFER & MSBR)	4.0	11.0	
c. HTGR	13.8	41.0	
d. LWBR	29.0	21.4	
e. Reactor safety research	48.6	61.2	
f. Waste management	6.2	11.5	
g. Uranium enrichment	57.5	66.0	
h. Resource assessment	3.4	10.4	
i. Other (incl. advanced tech.)	10.7	28.8	
Nuclear fusion	101.1	168.6	AEC
a. CTR	57.0	102.3	
b. Laser ***	44.1	66.3	
Other	53.5	157.5	
a. Solar	13.8	50.0	AEC, NSF
b. Geothermal	10.9	44.7	AEC, DOI, NSF
c. Systems studies	17.3	30.0	AEC, DOT, NSF, FEO, TREA, FPC & OT

1/ The AEC research budget was later increased by $40 million.

d. Misc.	11.5	32.8	NSF, DOI
Support programs			
Environmental effects research	169.7	303.4	AEC, EPA, NSF
a. Pollutant characterization, measurement & monitoring	16.3	37.4	
b. Transport of pollutants	26.6	55.6	
c. Health effects	72.6	112.5	
d. Ecological effects	27.3	65.0	
e. Social & welfare effects	17.5	19.8	
f. Environmental assessment & policy formulation	9.4	13.1	
Basic research	94.5	174.6	AEC, NSF
a. Materials	13.2	32.9	
b. Chemical, physical, engineering	30.8	58.1	
c. Biological	40.3	60.5	
d. Plasmas	2.8	8.2	
e. Mathematical	7.4	14.9	
Manpower development	6.3	8.5	AEC, NSF
Total (direct energy R&D)	999.1	1,815.5	
Total (support programs)	270.5	486.5	
Total (direct & support)	1,269.6	2,302.0	

*Agency codes:
AEC - Atomic Energy Commission
DOC - Department of Commerce
DOD - Department of Defense
DOI - Department of the Interior
DOT - Department of Transportation
EPA - Environmental Protection Agency
FEO - Federal Energy Office
FPC - Federal Power Commission
NASA - National Aeronautics and Space Administration
NSF - National Science Foundation
TREA - Department of Treasury

**Funds for high BTU gasification in the Office of Coal Research budget do not include Trust Fund amounts.

***Includes amounts for laser fusion directed toward military application.

11. Combination of Alternatives

In the interest of clarity of presentation this analysis has discussed separately each potential alternative form of energy. It is highly unlikely that there will ever be a single definitive choice to be made between any potential energy form and its alternatives. Each may have a role to play; some way make major contributions to our energy supplies, while others may be subordinated to lesser roles. Some alternatives may be developed rapidly; others may evolve more slowly, perhaps to make a more important contribution at a later date. Forecasting on the basis of present knowledge of the relative roles of these potential alternatives is a highly subjective exercise which must necessarily include a large measure of judgement as to future trends in such variables as the direction and pace of technological development, the identification of usable resources, the rate of national economic growth and changes in our life style.

It seems most probable that many alternatives will be developed to some degree. Understanding of the extent to which they may replace or complement offshore oil and gas requires reference to the characteristics of our total national energy system. Factors most relevant to the issues at hand are outlined below:

1. Historical relationships indicate that energy requirements will grow at approximately the same rate as gross national product.

2. Energy requirements can be constrained to some degree through the price mechanisms in a free market or by more direct constraints. One important type of direct constraint operating to reduce energy requirements is through the substitution of capital investment in lieu of energy, e.g., insulation to save fuel. Other potentials for lower energy use have more far reaching impacts and may be long range in their implementation -- they include rationing, altered transportation modes, and major changes in living conditions and life styles. Even severe constraints on energy requirements within the time frame of this statement.

3. Energy sources are not completely interchangeable. Solid fuels cannot be used directly in internal combustion engines for example. Fuel conversion potentials are severely limited in the short term although somewhat greater flexibility exists in the longer run and generally involves choices in energy-consuming capital goods.

The principal competitive interface between fuels is in electric power plants. Moreover, the full range of flexibility in energy use is limited by environmental considerations.

4. A broad spectrum of research and development is being directed to energy conversion - more efficient nuclear reactors, coal gasification and liquefaction, liquified natural gas (LNG), and shale retorting, among others. Several of these should assume important roles in supplying future energy requirements, though their future competitive relationship is not yet predictable.

5. Major potentials for filling the supply/demand imbalance for domestic resources are:

   - More efficient use of energy.
   - Environmentally acceptable systems which will permit production and use of larger volumes of domestic coals.
   - Accelerated exploration and development of all domestic oil and gas resources.
   - Development of the Nation's oil shale resources.

   Of the foregoing increased domestic oil and gas production offers considerable possibilities, although adequate incentives must exist for indicated and undiscovered domestic resources to be discovered and extracted.

6. The acceptability of oil and gas imports as an alternative is diminished by:

   - The security risks inherent in placing reliance for essential energy supplies on sources which have demonstrated themselves to be politically unstable and prone to use interruption of petroleum supplies to exert economic and political pressure on their customers.
   - The aggravation of unfavorable international trade and payments balances which would accompany substantial increases in oil and gas imports.
   - Apparent high costs of liquefying and transporting natural gas other than overland by pipeline.

12. Alternative within the Program - Government Exploratory Drilling Prior to Leasing

Exploratory drilling conducted by or sponsored by the Federal Government prior to holding a lease sale would be an alternative within the program. This would involve an alternative approach to one aspect of the present Federal leasing system. At the present time there is no exploratory drilling on the OCS prior to leasing. The U.S. Geological Survey receives all engineering and geological data from companies who have drilled on leases issued on the OCS. These data and geophysical data purchased on the open market are used by the Geological Survey to develop OCS lease policies and evaluate tracts prior to leasing.

Oil and gas companies spend millions of dollars acquiring geological and geophysical data, and on data processing and interpretations to enable them to compete in lease sales. In 1971, U.S. exploration expenditures were $2.4 billion, down from an historical peak of $3.4 billion in 1968. (This cost includes drilling and equipping exploratory wells, acquiring undeveloped acreage, lease rentals, geological and geophysical expenditures, test well contributions, land department costs including leasing and scouting, and other, including direct overhead.) 1/ The value of their information depends upon its exclusive and proprietary nature. Because of the high costs, companies generally combine in "group shoots" and share the expenses of seismic data acquisition or purchase data from geophysical service companies.

A very few companies have their own equipment and do their own work under research and development departments. Geophysical service companies acquire data on specific areas on a speculative basis hoping to sell it to several companies. Therefore, although several companies and the Government may have the same data it is proprietary to the purchaser and cannot be revealed. Each purchaser believes his competitive edge is its use in his interpretation and application.

Government exploratory drilling would have several advantages. It could establish the existence, possible extent, and quality of oil and gas resources, and signal problems that may occur if development follows. The Government

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1/ "What It Costs to Find Hydrocarbons in the U.S.," World Oil (October 1973), p. 77.

would be in a better position to take the initiative in selecting tracts to be included in a sale, evaluating resource potential, determining pre-sale estimated value, analyzing lease bids, and identifying environmental problems for the protection of sensitive areas through lease stipulations. At the present time, the oil and gas industry sometimes has more seismic data than the Government for some tracts and industry assists Government through the nominations process in the selection of specific tracts in a general area designated for leasing.

The availability of data from Government exploratory drilling would tend to eliminate the need for costly exploratory effort by industry and encourage companies to channel their efforts into the acquisition and development of producible leases. Availability of data from exploratory drilling could encourage smaller companies to participate in leasing by greatly reducing capital outlays required to evaluate tracts and reducing the competitive advantage of a few companies which possess exclusive data. These tendencies would be counteracted to the extent that companies distrusted Government findings and continued to undertake independent exploration and data acquisition.

Also, large companies having the same data and more money could still outbid smaller companies. However, data from exploratory drilling would provide significantly better resource evaluation than any other method.

The cost to the Government of an adequate exploration program would be tremendous, whether the Government contracted out the work or purchased and operated the equipment itself, hired its own personnel, and did all of its own analysis. For example, consider drilling costs alone. To drill a typical offshore exploratory will cost about $2.1 million dollars. Of this, about 65% represents operating costs and 22% mobilization and demobilization.[1/] Each company evaluates in depth only the most promising tracts and those in which it has a particular interest. In contrast, a Government exploration program would require a detailed evaluation including seismic work and coring and exploratory drilling, of extensive OCS areas, not of just a few tracts. Under present practice, the cost of seismic data collection is lowered by being "speculative data" for sale to many companies.

A Government exploratory drilling program would result in the Government assuming the risks and costs now borne by companies. Much of the resources devoted to data acquisition and interpretation by private industry would be

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[1/] "Finance and Economics of Offshore Operations," World Oil (July 1973) p. 86.

freed for development and production. Such a Government program would be tantamount to finding the oil for industry and leasing the reservoirs to be developed and produced.

The interpretation of these data to evaluate resource potential involves not only expertise using the latest state of the art but also highly sophisticated equipment. Under the present system, this expertise is found throughout many companies, each of which devotes a great amount of time and money to the development of better interpretative methods. Each company has its own interpretations and special knowledge, resulting in a diversity of approach to data analysis and use. Any company, as well as the Government, can miss the mark in evaluating a particular tract, but each company believes its competitive edge is its superior interpretation and use of data. Under a system where only the Government did exploratory drilling, the discovery rate could decline. Reserves which the Government underevaluated or overlooked might be less likely to be discovered.

The impacts of Government exploration would be essentially the same as industry's explorations. Industry is required to adhere to stringent standards developed by the Government and is inspected by Government employees enforcing those standards. It would be inappropriate to believe the Government would make standards significantly more stringent for its own operations than it has for industry operations.

A large number of environmental impact statements have been prepared by the Department of the Interior in connection with their offshore leasing program. Among the more recent are: Proposed Plan Development, Santa Ynez Unit, Santa Barbara Channel, Off California (FES 74-20, May 3, 1974); 1974 OCS Oil and Gas Lease Sale Offshore Texas (#34) (FES 74-14, March 22, 1974); and 1974 OCS Sale No. 36 Oil and Gas General Lease Sale, Offshore Louisiana (DES 74-49, April 30, 1974); Oil and Gas General Lease Sale Offshore Texas; Proposed Increase in OCS Oil and Gas Leasing by Ten Million Acres in 1975; Oil and Gas General Lease Sale Offshore Southern California; and Oil and Gas General Lease Sale Offshore Central Gulf of Mexico.

In addition to these statements the recent report of CEQ concerning offshore development on the Atlantic Coast and in the Gulf of Alaska 1/ provides pertinent data bearing upon any major policy decision on this area. Also

1/ OCS Oil and Gas - An Environmental Assessment, a report to the President by the Council on Environmental Quality dated April 1974.

studies have been performed by the National Science Foundation [2] and private organizations which provide relevant information on other forms of energy conservation and use.

The environmental consideration of the above mentioned alternatives, as stated in the reference works should be supplemented with the following factors which concern the MarAd Program. The adoption of any alternative which would curtail offshore development would also have the effect of reducing the use of resources and the pollution which may arise from the construction and operation of program vessels as detailed subsequently.

B. ALTERNATIVES TO THE MARAD PROGRAM

In the more restricted area of the MarAd Program itself, certain alternatives are possible. These would be direct alternatives to the MarAd Program.

1. DISCONTINUE THE PROGRAM

By refusing to provide MarAd Title XI assistance to the construction of drilling vessels and service craft in U.S. shipyards the following results could be expected: The general program of offshore development would continue and could involve the use of foreign-built vessels constructed without the benefit of strict U.S. safety and environmental standards. Although American built vessels would not be readily available, some construction of privately financed, American vessels would continue, expecially if a shortage of suitable vessels developed which raised the revenue potential of such vessels. With respect to the pace of offshore development, it might be decelerated slightly over a short term period as foreign vessel production was increased and economic pressures made U.S. private financing more viable.

The environmental effects of this action would be a lessening in the pollution associated with shipbuilding and in the use of materials. On the other hand, an influx of foreign-built, foreign flag vessels would provide our government with a lesser degree of control over the design, construction and operation of these vessels and consequently some lesser degree of environmental control.

2/ A Technology Assessment of Geothermal Energy Resource Development dated April 15, 1975.

2. SUSPEND THE PROGRAM

The program could be suspended in order to provide time to improve the environmental characteristics of the vessels and their operations. Such action alone, however, would have much the same effect as discontinuance of the program. If offshore development were to continue, the action would result in increased use of foreign vessels and ultimately greater reliance on privately financed vessels as prices for these services increased.

The intention of such action, break through in design prior to major construction, would not be greatly encouraged by this action because of the availability of alternative vessels.

3. MODIFY THE PROGRAM

a. Development of New Standards

In this connection reference should be made to the present standards for design, construction and equipment of offshore vessels. Such rules have been developed by the Department of the Interior, the Coast Guard and the American Bureau of Shipping. In addition, certain provisions of IMCO's 1973 Marine Pollution Convention such as the special requirements for drilling rigs and other platforms as described in Regulation 21 of Annex I, will apply to such vessels when the Convention comes into force, and present Law of the Sea proposals contemplate an international authority to set standards for environmental protection for vessels engaged in the exploration and exploitation of offshore minerals. At the present time vessels financed under the MarAd Program must comply with these requirements. An alternative would be for MarAd to attempt to devise environmental standards above and beyond those presently required. The difficulty with this approach is that the types of pollution which pose the most threat are those associated with the drilling process. It is questionable whether such a course of action would result in standards materially different than those presently in effect.

A necessary foundation to improving standards for offshore equipment and operations would appear to be increased research and development, especially on the part of the government. While there are presently government research and development projects in process concerning various aspects of marine pollution, little is being done in the areas of the design of offshore equipment to prevent pollution.

Although private industry has not undertaken work on a centrally coordinated basis for the design of offshore equipment to prevent pollution, the companies involved in the offshore drilling industry have through conferences and cooperation between drilling contractors, equipment vendors and operators developed the designs for many new sophisticated pieces of equipment and substantially improved existing equipment and systems to prevent pollution. Such equipment includes: blowout prevention equipment, riser and subsea control systems, well testing equipment, vessel sewage systems, drilling mud control systems, and well completion equipment and systems.

CHAPTER VI

ADVERSE ENVIRONMENTAL IMPACTS WHICH CANNOT BE AVOIDED UNDER THE PROGRAM

A. USE OF MATERIALS

As indicated in Chapter IV, the construction of oil and gas drilling vessels under the Title XI program will require the use of large quantities of steel and other mineral products. While a very large part of these minerals should be recycled, the mining and processing of these materials does involve environmental harm in the form of land use-change, air, and water pollution. However, when the amount of materials used are considered in terms of total production, the amounts are comparatively small. In addition, it is questionable whether domestic production would be reduced, and hence the environmental effects reduced, if construction of the vessels under the program did not take place.

The operation of the program vessels will also involve the consumption of diesel fuel and lube oil. The extraction and processing of these products involve impacts generally similar to those concerning materials used in construction. In a like manner, the amounts involved are small and it is questionable whether the program will have any effect upon total production.

B. OIL SPILLS

Chapter III sets out the various types of oil pollution which oil and gas drilling vessels are likely to produce. Chapter IV describes measures which may be taken to lessen the amounts and effects of oil pollution from oil and gas drilling vessels. These include enforcement of various vessel safety and operation standards, and other measures for controlling, containing, and cleaning up spilled oil. As that and other Chapters indicate, while reduction is possible, some oil pollution is bound to occur.

Operational discharges for the most part can be controlled within limits; however, accidental discharges, especially those from casualties, result from the fallibility of man and are more difficult to control. Various safety measures can reduce the chances of accidents and minimize their effects when they occur, but environmentally significant oil spills from accidents involving oil and gas drilling vessels are a distinct possibility.

When oil discharges from oil and gas drilling vessels occur they can have the following environmental effects.

Pollution can affect, in varying degrees, all forms of marine plant and animal life from those that are the lowest in food chain to those at the top. The degree of pollution duration and the physical condition under which it occurs determines the extent of the impact. After the pollution has occurred, a normal balance may be regained in a short period of time or the impact may be more severe and recovery may require a span of many years.

Little is known of what effect the chronic incremental discharge of oil may have on the marine food web. In addition to the effects upon plant and animal life, oil discharges of the chronic type, or major spills could affect beaches, water areas and historic sites making them at least temporarily unusable for recreational purposes. If such pollution incidents occurred during periods of normal heavy visitor use, loss of recreational enjoyment and economic benefit to the vicinity could be substantial. Fishing, water sports, boating and many other marine related activities could be made much less attractive for an indeterminate period, depending upon the promptness and efficiency of the cleanup operation.

C. OTHER ADVERSE IMPACTS

The foregoing subchapters detail the major environmental impacts of the Title XI Offshore Oil and Gas Drilling Vessel's which cannot be avoided. The program will also involve some other impacts which are of lesser significance or which can be attributed only in part to the program. Small amounts of air, water noise, and solid waste pollution will result from construction, operation, repair, and scrapping of these vessels. These forms of pollution can be and are likely to be kept within the limits of local, state, and national standards for these forms of pollution.

CHAPTER VII

RELATIONSHIP BETWEEN LOCAL SHORT TERM USE OF THE ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG TERM PRODUCTIVITY

The principal short term use of the environment resulting from the program will be the construction of the vessels with the attendant dedication of mineral resources, primarily steel, and possibly limited land resources devoted to shipbuilding and port development. These uses should have a relatively small effect upon the long term productivity of our national environment.

The operation of program vessels may contribute to some extent to the development of offshore oil and gas and consequently may contribute to the diminishment of the long term productivity of these mineral resources, in a similar manner the use of these vessels could lead to some lessening of the long term productivity of marine and coastal resources. In connection with the latter point, it should be noted that the long term effects on the oceans of low-level pollution from oil and toxic chemicals are not clearly understood at this time. The additional stress the ecosystem can absorb is limited, but at present the bounds of these limitations are not known. Construction of pipelines and related facilities, if properly conducted, should have a short term affect upon the coastal environment with recovery after a period of time.

CHAPTER VIII

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

A. MINERAL RESOURCES

The construction and operation of program vessels will involve the use of mineral resources, primarily steel, fuel and lube oils, some of which cannot be recovered. The character of these mineral resources is not unique nor will the quantities used be such that their use is significant in terms of our national resources. To a certain extent the program will facilitate the development and extraction of offshore mineral resources. To the extent that these vessels contribute to the production of these resources they also contribute to their irreversible and irretrievable commitment of them.

B. LAND RESOURCES

As previously indicated, program vessels may contribute to the pressure for the development of shipyards and port facilities with attendant dedication of land. Further, by facilitating offshore development, the program may contribute to a certain extent to onshore and coastal zone construction associated with oil field development, such as pipeline construction.

C. FISH AND WILDLIFE RESOURCES

An irreversible or irretrievable commitment of fish and wildlife resources and their habitats could occur in the area of a large oil spill, or if frequently subjected to chronic low-levels of oil pollution. At this time there is insufficient evidence to conclude that low-level spillage has led to an irreversible commitment of living resources; however, this matter deserves further study. More dramatic, though less probable, are the major oil spills that could occur. The extent and severity of such a spill's effects would depend on a number of circumstances which cannot be predicted with accuracy.

CHAPTER IX

CONSULTATION AND COORDINATION WITH OTHERS

This section presents an account of the consultation and coordination processes involved in the preparation of the draft environmental impact statement (DEIS) which was made available to the public on May 2, 1975, the period of review of the DEIS, and the steps leading to the preparation of the final environmental impact statement (FEIS). All official review comments of the DEIS are attached and where appropriate, the disposition of pertinent comments leading to the preparation of the FEIS are indicated.

Chapter III has been totally restructured and other chapters revised to reflect all comments pertaining to the original draft wherever considered appropriate.

A. <u>PREPARATION OF THE DRAFT ENVIRONMENTAL IMPACT STATEMENT</u>

1. FEDERAL AND INDUSTRY PARTICIPATION

In order to develop the draft environmental impact statement on Title XI Vessels Engaged in Offshore Oil and Gas Drilling Operations it was determined that other Federal agencies and the oil drilling industry should be contacted to provide the necessary expertise that would assist in the preparation of the DEIS. Accordingly the Maritime Administration established an Ad Hoc Working Group comprised of representatives of government and industry to undertake the task of describing or providing information, on those specific areas of offshore drilling operations in which each representative was most knowledgeable.

The government and industry participation in the development of the DEIS were as follows:

Department of the Interior

Office of Environmental Project Review

U.S. Geological Survey

Department of Transportation

U.S. Coast Guard

Environmental Protection Agency

Department of Commerce

National Oceanic and Atmospheric Administration

International Association of Drilling Contractors

American Bureau of Shipping

The Offshore Company

National Oceanic Industries Association

Offshore Marine Services Association

The following Federal agencies were also invited to comment on the DEIS in addition to those listed above:

Department of State

Department of Defense

Department of Treasury

Atomic Energy Commission

Federal Power Commission

Energy Research and Development Administration

2. STATE PARTICIPATION

In the preparation of the Draft Environmental Impact Statement, coastal States were not formally requested to submit information or comments for inclusion in the DEIS. Active State involvement was solicited in review of the program as it was presented in the DEIS. All State comments were considered in the preparation of the Final Environmental Impact Statement and are included in this Chapter.

B. COORDINATION AND REVIEW OF THE DRAFT ENVIRONMENTAL IMPACT STATEMENT LEADING TO PREPARATION OF THE FINAL ENVIRONMENTAL IMPACT STATEMENT

After the DEIS was prepared, copies were made available to Federal and State governmental agencies and the public. Comments and views were solicited from those agencies which have some mandate for enforcing and developing environmental standards.

In addition, comments and advice were solicited from the public and the oil and gas drilling industry through formal and informal coorespondence. All review comments of the draft environmental impact statement were considered and, where appropriate, the disposition of the comments is indicated and any unresolved issues are identified.

Remarks concerning disposition of comments are to be found immediately following each letter received which has been reproduced verbatim. In this way, it is hoped that the Department's responses to many of the issues raised can be easily located and oriented to the agency or person that originated the comment.

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

In Reply Refer To:
EGS-ER-75/447-MS108

JUL 11 1975

Dear Mr. Blackwell:

This Department has reviewed the draft environmental statement on Title XI Vessels Engaged in Offshore Oil and Gas Drilling Operations. The statement is valuable as a concise source of information on vessel types and designs, and for a good summary of Federal and State regulatory activities in coastal and offshore areas. We note that the statement covers only the administrative action of having the Federal Government guarantee the obligations of private ship builders, and so the environmental implications are indirect, in that offshore oil and gas operations would be encouraged.

The draft statement carefully considers impacts on salt-water resources and to a lesser extent those on surface-water resources, especially estuaries. It should also, however, consider potential impacts on ground-water resources that may result from the implementation of the proposed action. Specifically, the following should be treated, at least briefly:

(1) All drillholes which penetrate subsea extensions of artesian aquifers are potential avenues for the release of artesian pressures; such decreases may then ultimately have effects on land. For example, accidental or planned withdrawals of water through the drillholes, during exploration or development, may affect sub-land portions of the aquifers some miles away, causing increases in the rate of decline of water levels and subsidence of the land surface; hastening of salt-water encroachment into fresh-water aquifers can also result. Withdrawal of other fluids under certain circumstances may also cause distant subsidence. Most of these effects would probably be serious only in comparatively near-shore situations where large-scale development of petroleum or gas might occur;

most effects can probably be avoided by compliance with regulations as mentioned on pages IV-1 to IV-6 but possible impacts and mitigating measures should be evaluated. It is probable that the very large proportion of non-productive holes indicated by Table 1-1 would be most suspect; for example, a casing not fully plugged through all aquifers may soon rust out and allow wild flows of large amounts of fresh water to occur continuously.

(2) Effects of oil spills and chronic oil discharges on recharge to shallow aquifers, especially in areas of very permeable surface materials such as beach sands or pebble beaches, should be mentioned. Lenticular fresh-water bodies beneath such materials are often entirely or largely dependent upon direct infiltration of precipitation and therefore are directly subject to conditions such as those described in item 14 on page III-35. Effects of pipeline breaks on shallow aquifers should also be considered.

The resource estimates listed on Table III A-1 are not in accordance with the latest Geological Survey evaluations which are to be published in the Bureau of Land Management final programmatic impact statement, related to the proposed increase in OCS leasing. Reference might also be made to U.S. Geological Survey Circular 725, "Geological Estimates of Undiscovered Recoverable Oil and Gas Resources in the United States" (copy enclosed).

The last sentence in the second paragraph on page III-3 is misleading and should be deleted. During exploratory and development drilling, mud is circulated through the drill string and back up the annulus to the rig, no matter what the water depth. In deeper water, where floating rigs are utilized, the casing head and blowout-prevention equipment are on the ocean floor. However, a drilling riser connects the ocean floor equipment to the rig and allows the mud and cuttings to be circulated.

We do not follow the rationale used in arriving at the conclusion in paragraph 2 on page III-22 that there is a higher probability of an extremely large spill from large pipelines than from tankers. Table III A-7 clearly predicts that both number and volume of spills would be greater for tankers than pipelines. Also, the text states that the possibility of spills greater than 1,000 barrels is greater for tankers than for pipelines. The largest oil

spill from an OCS pipeline to date was about 160,000 barrels. However, with the controls that are presently required on OCS pipelines (pressure sensors, volume measurements), recurrence of such a spill would be extremely improbable today. The comparison needs more careful analysis.

In most drilling operations, drilling mud is not routinely discharged overboard (p. III-24), last paragraph). Heavy, highly treated drilling muds are quite expensive and are efficiently recycled and reused. Mud discharge is generally limited to small amounts of materials which cannot be effectively separated from the drill cuttings. The exact amounts of muds which are actually discharged are highly variable and difficult to determine.

The statement regarding safety devices on page IV-5 is in error. The high-low pressure sensing devices and automatic shut-in valves on pipelines are required on production platforms, not on exploratory drilling rigs. Additional safety requirements on all OCS drilling relate to well casing and cementing, blowout-prevention equipment, mud programs, well control surveillance and training, and hydrogen sulfide safety programs.

The statement should indicate the effect the Title IX is expected to have on the number (and types) of vessels engaged in offshore oil and gas exploration activity. This can then be related to impact analysis to arrive at the net environmental impacts attributable to the program. This will provide perspective as to the scope of the program, an essential item now missing from the statement.

Some additional references and more detailed corrections are attached for use in revising the statement.

We appreciate the opportunity to review this draft statement and we hope that you will find our comments constructive and useful in the preparation of the final statement.

Sincerely yours,

Stanley D. Doremus

Deputy Assistant Secretary of the Interior

Mr. Robert J. Blackwell
Assistant Secretary
for Maritime Affairs
The Maritime Administration
Department of Commerce
Washington, D. C. 20230

Enclosures

The following are some additional references that have come to our attention and may be useful in revising the EIS:

Anderson, J.W., 1974, Laboratory studies on the effects of oil on marine organisms: Texas A & M Univ., rept. in prep. for Am. Petrol. Inst.

Burns, K.A., and Teal, J.M., 1973, Hydrocarbons in the pelagic sargassum community: Deep Sea Research, 20, p. 201-211.

Vaughan, B.E., ed., 1973, Effects of oil and chemically dispersed oil on selected marine biota--A laboratory study; Battelle-Northwest Labs., Richland, Wash.; Am. Petrol. Inst. Pub. No. 4191, Wash., D.C.

The data in Table I-1 (p. I-5) would be more meaningful if complete years were compared rather than the first half of two succeeding years.

While the operators of the SEDCO 445 (p. I-10) state its capability to 3,000 feet, the deepest water in which it or any other drill ship has been worked, using a circulatory mud system, is its present location in 2,300 feet.

In Table III A-2 (p. III-9) the last line should be "heat (not "head") exchangers."

Offshore Technology Conference paper OTC 2390 "Influx of Petroleum Hydrocarbons into the Oceans" by Charles C. Bates, U. S. Coast Guard, and Earman Pearson, University of California, has up-to-date information on the subject of oil pollution sources (p. III-10).

Another reason for the apparent lack of significant decrease in the number of pollution incidents (p. III-13, paragraph 2) is the improvement in recording and reporting practices.

The first sentence in paragraph 2 on page III-25 should read "During production operations, waters from the . . ."

"Offshore vessels" should evidently be "drilling and service vessels" (p. V-1, line 11).

The following should be added to the list of recent OCS environmental statements on page V-2, paragraph 2: (1) Oil and Gas General Lease Sale Offshore Texas; (2) Proposed Increase in OCS Oil and Gas Leasing by Ten Million Acres in 1975; (3) Oil and Gas General Lease Sale Offshore Southern California; and (4) Oil and Gas General Lease Sale Offshore Central Gulf of Mexico.

The proposed alternative of modifying the program by giving preference to certain vessel designs that are more environmentally sound than others (p. V-4 to V-5) appears not to be a real alternative but to be a part of the MarAd Title XI Program as presently administered. It had been stated earlier (p. IV-17) that the Maritime Administration "reviews technical plans and specifications to ensure that the vessels/rigs are in conformance with good shipbuilding practices and that these units comply with standards established by such regulatory bodies as U. S. Coast Guard, Environmental Protection Agency, American

Bureau of Shipping, etc." It has been explained that the regulatory standards are intended to increase safety and protect the marine environment. The fact that this alternative is not a modification of the present program, but a part of it, appears to be acknowledged by the conclusion that "the impacts of this course of action would be the same as continuing the program as it presently exists" (p. V-5, lines 5-6).

Department of the Interior (DOI)

The DOI offered numerous substantative comments designed to improve and expand on those sections dealing with ground-water resources, oil and gas resources, oil spills, drilling technology and safety devices and the recommendation that the Title XI Program description be elaborated upon.

Disposition

Page 1, para. 1 - No disposition required.

Page 1, para. 2 and 3 (1) - The comments relative to sub-sea aquifers being penetrated during drilling operations and the possible subsidence of nearby land areas are considered to be beyond the scope of this environmental impact statement. A review of numerous DOI environmental statements relative to the exploration and exploitation of the outer continental shelf revealed no discussion on the subject of aquifers and only a brief mention of land subsidence in the Santa Barbara Channel area as a result of production wells extracting hydrocarbons.

Table 1-1 has been replaced with a more meaningful and up to date table; and with regard to a well casing not being fully plugged, the reader is referred to the following passage from DOI draft environmental statement Oil and Gas Development in the Santa Barbara Channel (DES 75-35): "Plugging and abandonment operations must be in conformance with Geological Survey regulations and such operations cannot be commenced prior to obtaining approval from the Geological Survey. The regulations specify acceptable alternate abandonment procedures for various well conditions, open hole, perforations, etc., and specify tests to ensure that formations are isolated and that the well is left in a safe condition."

Page 2, para. 4 (2) - Chapter III has been completely restructured, however, for the reasons stated above, oil effects on aquifers has not been included.

Page 2, para. 5 - Table IIIA-1 has been deleted.

Page 2, para. 6 - Comment is reflected on page III-71.

Page 2, para. 7 - The statement that there is a higher probability of an extremely large spill from large pipelines than from tankers has been removed.

Page 3, para. 8 - Comment is reflected in the revision of Chapter III on page III-71.

Page 3, para. 9 - Page IV-4, para 2, has been revised to reflect the comment relative to safety devices.

Page 3, para. 10 - Chapter I has been restructured to provide perspective as to the scope of the Title XI Program as it relates to the number and types of vessels engaged in offshore oil and gas drilling operations.

Page 3, para. 11 - Added additional references where appropriate

Detailed Comments

Para. 1 - Table I-I has been replaced.

Para. 2 - Page I-10 (new page I-13) has been revised to indicate a water operating depth of 2,300 feet in lieu of 3,000 feet.

Para. 3 - Correction has been made.

Para. 4 - Chapter III has been completely revised and now indicates up-to-date information on oil pollution sources.

Para. 5 - Improvements in recording and report pollution incidents has been mentioned in the revision of Chapter III. (Page III-13).

Para. 6 and 7 - Editorial corrections have been made to Chapters III and V.

Para.8 - The list of OCS environmental statements has been included in Chapter V.

Para. 9 - The comment that the proposed alternative of "modifying the program by giving preference to certain vessel designs that are more environmentally sound than others is not a real alternative" is concurred with and has been deleted from the Final EIS.

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

2 7 JUN 1975

OFFICE OF THE ADMINISTRATOR

Dr. Sidney R. Galler
Deputy Assistant Secretary
Environmental Affairs
Department of Commerce
Washington, D.C. 20230

Dear Dr. Galler:

The Environmental Protection Agency, pursuant to its responsibilities under the National Environmental Policy Act and Section 309 of the Clean Air Act, has reviewed the draft environmental statement for Title XI Vessels Engaged in Offshore Oil and Gas Operations. In general, we believe the statement presents a competent analysis of the Offshore Oil and Gas Drilling and Support Vessel Program and the environmental impacts associated with the program's implementation. There are a few specific issues, however, that should be clarified in the final statement. These are enumerated below:

Page I-4. It is not clear from the statement whether the MARAD offshore drilling program is ongoing or proposed, since no historical reference is cited for the offshore program's inception. Information should be given to explain this program's time frame and its relevance to the National Environmental Policy Act of 1970.

Page III-8. Improper disposal of oil-contaminated drill cuttings and drilling muds may be in violation of EPA's soon to be proposed effluent limitations for the oil and gas extraction industry (see EPA's Draft Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the Oil and Gas Extraction Point Source Category). Such discharges will be subject to NPDES permits issued under Section 402 of the Federal Water Pollution Control Act, as amended, upon condition that the discharges will meet the requirements under Sections 304, 306, and 307 of the same Act. This and other references to the Act (page III-46 and III-50) should be modified to reflect the current status of the implementation of this law. In this connection, we also mention that overboard discharge of muds in territorial waters may be in violation of Federally approved State water quality standards.

Page III-16. Although equipment is quite thoroughly described, the discussion of pipeline placement and attendant impacts is not adequate. The final should be more thorough in detailing the pipeline laying operation and the extent and duration of environmental disturbance.

Page III - 20. The discussion of oil spills from single point mooring facilities and fixed berth facilities may present an invalid comparison of spill probability. SPM spill data are somewhat dated and are compiled from a number of facilities, whereas fixed berth information has been derived from one port with an outstanding record for few spills. A more equitable comparison of situations would be appropriate in the final statement.

Page III - 58. Shipyard construction or expansion may be necessary to accommodate the increasing demand for offshore drilling vessels. Clearly, the development of drilling rig construction sites will cause serious socio-economic impact on small communities. The final should examine this issue when evaluating secondary impacts.

Page III - 59. The statement mentions the necessity of dredging access channels to construction and repair facilities to accommodate wide, deep draft semi-submersible rigs. The final should describe the impact of this dredging and discuss the disposal of the dredged spoil.

Page III 69. This material indicates that shipyards will periodically place oil and water on unpaved roadways to suppress dust. EPA has found that a large percentage of oil used for dust prevention on dirt roads eventually finds its way into adjacent waterways, and that this practice is therefore environmentally objectionable.

In accordance with the EPA rating system for environmental impact statements, we have classified this statement as LO-2. This means we have no substantive objection to the described activity, but feel that more information, as requested in our specific comments, is needed.

We thank you for the opportunity to review this statement and hope our comments will assist in the preparation of the final statement.

Sincerely,

Rebecca W. Hanmer

for Sheldon Meyers
Director
Office of Federal Activities

Environmental Protection Agency (EPA)

Page 1, para. 2 (Page 1-4) - Chapter I has been restructured to provide a more descriptive background of the Title XI Program and its relationship to the offshore drilling industry. With regard to the Program's relevance to the National Environmental Policy Act of 1970, it was determined that the Program constituted a major Federal action that could effect man's use of the environment; therefore, it was felt that the publishing of an environmental impact statement was necessary under Section 102(2)(C) of NEPA.

Page 1, para. 3 (Page III-8) - Chapter III has been completely restructured, and page III-71 reflects the comment relative to overboard discharges of drill cuttings and drilling muds.

Page 2, para. 4 (Page III-16) - Page III-75 has been revised to describe pipeline laying and the resultant environmental disturbances.

Page 2, para. 4 (Page III-20) - The comparison of oil spills from single point mooring (SPM) facilities and fixed berth facilities has been deleted as not being pertinent to an EIS of this nature. Mention of SPM's, however, has been retained.

Page 2, para. 5 (Page III-58) - Shipyard construction or expansion to meet the demand for offshore drilling vessels is extremely unlikely, and Chapter III has been revised to reflect this improbability.

Page 2, para. 6 (Page III-59) - Page III-78 discusses the dredging of access channels and indicates the role of the U.S. Army Corps of Engineers relating to any such dredging needs.

Page 2, para. 6 (Page III-69) - The oiling of unpaved roadways at shipyards was found to be obsolete, and the practice has largely been discontinued (Page III-82).

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS:
U.S. COAST GUARD (G-WEP-2/73)
WASHINGTON, D.C. 20590
PHONE: 202-426-9573

5922/9.a

3 JUN 1975

Mr. Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs
Department of Commerce
Washington, D. C. 20230

Dear Mr. Galler:

This is in response to your letters of 2 May 1975 addressed to the Assistant Secretary for Environment, Safety and Consumer Affairs, Department of Transportation, and the U. S. Coast Guard, concerning the draft environmental impact statement, Maritime Administration, Title XI - Vessels Engaged in Offshore Oil and Gas Drilling Operations.

The United States Coast Guard has reviewed the statement and we offer comments as follow:

Page III - 20, Provide oil spill data for single point moorings (SPM's) which appear to be based on "Bayesian Analysis of Oil Spill Statistics," J. W. Devanney and R. J. Stewart, Marine Technology, October 1974. The figures of 108 spills in 5,578 ship calls are industry statistics for 10 Shell Oil Company loading SPM's, while Durban is an unloading SPM and its spill record is not included in these figures. None of these facilities is located on the outer continental shelf where vessels constructed under the proposed program would primarily be utilized. Therefore, these figures may not be representative of SPM's associated with outer continental shelf oil development where sea and weather conditions would be more severe.

On page IV-2, reference is made to some provisions of the 1973 IMCO requirements for fixed and floating drilling rigs and on page V-5, reference is made to applying some of the provisions of the 1973 Marine Pollution Convention to vessels built under the proposed project. Since this Convention has not yet been ratified, the sections to be applied should be clearly identified and the reasons for not requiring compliance with other provisions, and the environmental impacts of such non-compliance, should be justified.

The proposed program consists primarily of guaranteeing vessel mortgages and not ship design and construction. Table 1-2, on page 1-7, lists the number of applications received and approved under this program, but does not give figures on the dollar amount of mortgages guaranteed. Since this program is primarily financial in nature, it would be appropriate to give some dollar figures on the size of the government's commitments in the EIS describing the project, and the economic impact of those commitments.

3 JUN 1975

Subj: Reply to Mr. Galler's letters of 2 May 1975 concerning the draft environmental impact statement, Maritime Administration, Title XI - Vessels Engaged in Offshore Oil and Gas Drilling operations

The Coast Guard regulations concerning marine sanitation devices have been promulgated and are attached as enclosure (1).

The current National Contingency Plan was revised as of 10 February 1975 (enclosure (2)). The plan is substantially the same as the superseded version and no change is required in your description (page IV-24 and 25) except for the last sentence.

The opportunity to review the statement is appreciated.

Sincerely,

James A. Atkinson

JAMES A. ATKINSON
Commander, U. S. Coast Guard
Assistant Chief, Marine Environmental
Protection Division
By direction of the Commandant

Enclosures

Department of Transportation
U.S. Coast Guard (USCG)

Page 1 (Page III-20) - In the revision of Chapter III the comments relative to single point moorings and oil spill statistics have been incorporated.

Page 1 (Page IV-2) - Page V-5 of the DEIS has been revised to incorporate the comment and the sections of the IMCO 1973 Marine Pollution Convention that will apply to the program vessels have been identified. The remainder of the comment relative to - reasons for not requiring compliance with other provisions" - is not clear and would fall beyond the purview of this statement.

Page 1, Last para. Chapter I has been revised and now provides the number of applications received and the figures on the dollar amount of mortgages guaranteed under the program.

Page 2 - Comments on page 2 of the U.S. Coast Guard letter have been incorporated into the FEIS.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Rockville, Md. 20852

June 17, 1975

TO: Sidney R. Galler

William Aron RLLehman for

SUBJ: DEIS - Maritime Administration: Title XI-Vessels Engaged in Offshore Oil and Gas Drilling Operations

Attached are comments from the NOAA-National Marine Fisheries Service, Environmental Data Service, National Weather Service and Marine Ecosystems Analysis Project on subject DEIS.

Attachments

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL DATA SERVICE
Washington, D.C. 20235

Date : June 11, 1975

Reply to Attn. of: Dx6/LAP

To : William Aron
Director, Office of Ecology and Environmental Conservation, EE

From : Lewis A. Pitt
Special Projects

Subject: EDS Review of Maritime Administration DEIS: Title XI-Vessels Engaged in Offshore Oil and Gas Drilling Operations

The EDS has reviewed the subject DEIS and offers the following comments:

> When this office reviewed the original Maritime Administration (MARAD) paper, which was the forerunner to the present DEIS, we critically commented on the environmental description. We also offered to assist the Agency in rewriting the applicable section (see attachment). The EDS offer was not followed through by MARAD.
>
> We note now that the DEIS marine environment is described only in general terms (see Chapter II) and the physical oceanography portion has been eliminated. For a detailed discussion the reader is referred to a U.S. Department of Interior Draft EIS: "Proposed Increase in Acreage to be Offered for Oil and Gas Leasing in the Outer Continental Shelf, DES 74-90, October 18, 1974 (Page II-1), which is no longer in our files.
>
> The EDS reviews approximately 40 DEIS per month. These range from approximately 30 pages to as much as 500 pages each. Multiply this by the number of agencies who review the DEIS and the number processed strains the imagination. To further require that these publications be archived in anticipation that a later DEIS will refer back to a stored document not only creates a space/storage/indexing nightmare, it also delays the processing of the environmental statement.
>
> In lieu of referring to a separate archived DEIS for an environmental description, EDS recommends that the pertinent portion be extracted by the preparing agency and included in the subject DEIS under consideration. This procedure will provide a complete document and facilitate its review. Other POEs are encouraged to comment.

Attachment

cc:

G. Lill, NOS	D. Evans, NMFS	F. Hebard, MR-5
W. Hess, ERL	R. Burns, PMEL	A. Peterson, NWS
T. LaRoe, CZM	R. Pyle, NESS	H. Stewart, AOML
Cdr. Swanson, MESA		

September 25, 1974 Dx6

Dr. William Aron, EE

Lewis A. Pitt
Special Projects Staff

Clarification of NOAA Comments on MarAd Discussion Paper on Title XI - Vessels Engaged in Offshore Oil and Gas Drilling Operations
(Ref. your memo, same subject, September 19, 1974)

MarAd's suggestion that NOAA undertake the task of providing the actual input and revise the language and analysis as necessary is acceptable. NOAA/EDS would be happy to rewrite the physical oceanography section (Chapter II, Section I, pages 48-35) of the paper if funds are furnished. It will take one man about 2 to 3 weeks to do the job at a cost of approximately $1200-$1800.

As an alternate option, EDS would welcome a visit by the MarAd writer of the paper. We would show him where the errors were noted and provide the reference sources necessary to cover missing areas and strengthen other descriptive portions.

LAPitt:jas

F34/BEH

To : EE-Office of Ecology and Environmental Conservation

From : Associate Director for Resource Management, F3

Subject : MarAd DEIS on Title XI, Vessels Engaged in Offshore Oil and Gas Drilling Operations (DOC)

The National Marine Fisheries Service has reviewed the subject DEIS and offers the following comments:

General Comments

We appreciate the fact that because "Oil and gas exploratory drilling units and support vessels built under the MarAd Title XI Program could operate at any offshore area in any ocean of the world" (Page II-1), only a general discussion of the marine environment is warranted. However, to refer the reader to the Department of the Interior's DEIS for "Proposed Increase in Acreage to be Offered for Oil and Gas Leasing on the Outer Continental Shelf" seems inappropriate, in view of the voluminous, critical comments of NMFS/NOAA/DOC concerning the numerous deficiencies of this DEIS, including the section on 'Description of the Environment."

Sections II and III of the subject DEIS, although not completely satisfactory to us, are nevertheless greatly improved over those presented in the Discussion Paper we previously reviewed. Therefore, unless other agencies or individuals submit comments requesting additional data or information on fisheries or the marine environment that NMFS could perhaps seek to provide, if specifically requested to do so within a reasonable period of time, we will have no further comments or suggestions to offer relative to development of the FEIS for this program.

W16/GAF

June 4, 1975

William Aron
Director, Office of Ecology and Environmental Conservation, EE

George P. Cressman
Director, National Weather Service

Maritime Administration DEIS: Title XI - Vessels Engaged in Offshore Oil and Gas Drilling Operations.

Subject DEIS fails to address the effects of weather and climate on equipment systems now in use in the OCS zone. Omitted entirely is discussion of weather and sea limitations on equipment, either by general type or category. Therefore, the potential for limited or catastrophic failure is not addressed, and the environmental impact conclusions consequently are deficient in this respect.

JUN 1975

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL RESEARCH LABORATORIES
MESA Project Office
Old Biology Building
S.U.N.Y.
Stony Brook, New York 11794

Date : 3 June 1975

To : W. Aron

From : R. L. Swanson R. L. Swanson

Subject: Maritime Administration DEIS: Title XI-Vessels Engaged in Offshore Oil and Gas Drilling Operations.

The discussion of environmental and ecological effects in the subject EIS is very brief and general. While this general discussion appears accurate insofar as it goes, it is a very brief treatment of the most significant impacts.

In Table 12 (p. A-29) it appears that the concentrations of light and heavy oils from the work of Frankenfeld are reversed, i.e., the light oils should be 3.5 ppm and heavy oils should be 0.7 ppm (which is consistent with Fig. 5 on p. A-22).

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Rockville, Md. 20852

June 30, 1975

TO: Sidney R. Galler

FROM: William Aron WA

SUBJ: MarAd DEIS: Title XI - Vessels Engaged in Offshore Oil and Gas Drilling Operations

Attached are late comments on subject document from the Coastal Zone Management Office.

Attachment

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Rockville, Md. 20852

JUN 20 1975

Date : June 19, 1975

Reply to Attn. of:

To : William Aron
EE

From : Edward T. LaRoe
OCZM

Subject: Comments on MarAd DEIS: Title XI - Vessels Engaged in Offshore Oil and Gas Drilling Operations

This document has been reviewed only in the narrow context of the relation of the proposal to the Office of Coastal Zone Management and its responsibilities. In this context it would appear that OCZM's role and activities have been described in the subject document in a restrictive and incorrect fashion. For example:

p. IV-16: The CZM Act provides much more than simply "a framework for Federal-state cooperation in planning for onshore and offshore development induced by OCS operations..." OCZM's charge under the Act is, of course, far broader, and its role in OCS planning should be set in this wider context. The correct title of the Act is The Federal Coastal Zone Management Act, not the Coastal Zone Land Management Act.

p. IV-19: Incorrect title.

p. IV-21: Perhaps the greatest strength of the CZMA is that programs developed under it will not be single purpose plans, but will address a multitude of coastal resource needs and uses. States should not only give priority to developing plans prior to OCS leasing, but must be sure to include a balanced approach, taking into account these other values and resources. The implication that this is in fact a weakness of the program should be removed.

p. IV-22: Correct the 4th sentence to read: "Further, as part of its coastal management programs, established under the Coastal Zone Management Act of 1972, particular areas within a state's jurisdiction can be set forth as non-available for drilling operations, if such a decision is based on a rational and balanced decision-making process."

Thank you for the opportunity to comment.

<u>Department of Commerce</u>
<u>National Oceanic and Atmospheric Administration (NOAA)</u>

The Environmental Data Service of NOAA in their letter of June 11, 1975 (DX6/LAP) in essence objected to Chapter II in which reference is made to a Department of Interior DEIS for a complete description of the marine environment. The comment was considered valid and Chapter II has now been restructured and, although the description of the marine environment remains somewhat general due to the nature of the program, referring the reader to other environmental impact statements has been removed, additional information is included, and a section on the geology of oil and gas accumulation has been added.

The undated memorandum from the Associate Director for Resource Management, F3 (F34/BEH) of the National Marine Fisheries Service (NOAA) makes a similar comment to that received from the Environmental Data Service, therefore the disposition contained in (1) above also applies to the NMFS comment.

Memorandum from the Director, National Weather Serviced dated June 4, 1975 (W16/GAF) states that the DEIS fails to address the effects of weather and climate on equipment systems now in use on the OCS zone, etc. This comment is not considered valid as the EIS, beginning on page 1-14 describes the design of the equipment, including mooring devices, for the drilling rigs to operate in the most adverse sea and wind conditions.

Memorandum from R. L. Swanson of Environmental Research Laboratories dated 3 June 1975.

Para. 1 - Chapter II has been revised as stated in (1) and (2) above.

Para. 2 - Corrections to Table 12 (p. A-29) have been made in accordance with the comment.

Memorandum from Edward T. LaRoe, Office of Coastal Zone Management (OCZM), dated June 19, 1975.

Comment relative to p. IV-16: Corrections have been made to reflect a broader role of OCZM under the Coastal Zone Management Act. The title of the Act has also been changed in accordance with the comment.

Comment relative to p. IV-19: Title of the Federal Coastal Zone Management Act has been corrected.

Comment relative to p. IV-21: The comment relates to the second paragraph on page IV-21 of the DEIS. This paragraph has now been deleted in its entirety in response to the comment.

Comment relative to p. IV-22: Corrections have been incorporated verbatim.

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

SEP 5 1975

Mr. George C. Steinman, Chief
Environmental Activities Group
Maritime Administration
U.S. Department of Commerce
Washington, D. C. 20230

Dear Mr. Steinman:

This is in response to the letter of May 2, 1975, from Dr. Sidney R. Galler inviting the U.S. Energy Research and Development Administration (ERDA) to review and comment on the Department's Draft Environmental Statement (MAEIS-2302-75022-D) prepared by the Maritime Administration for its Title XI Vessels engaged in Offshore Oil and Gas Drilling Operations. It is quite obvious that future exploratory and drilling operations to be environmentally acceptable should have and need the most modern drilling and support vessels.

We should like to provide the Department with some comments generated by our review. We understand that, although our comments are being transmitted after the comment period has expired, for which we apoligize, they may be helpful in the preparation of the Final Statement.

The Statement carries with it a general feeling that because of the infinite vastness of the oceans that minor insults resulting from oil and gas production will not be noticeable but still it recognizes the need for quantitative data on the effects of low level chronic discharges of petroleum and drilling chemicals.

The Statement does an adequate job of summarizing the important aspects of the marine ecosystem and its basic components. There is very little depth on how the system functions, and how the different components interrelate, but overall, the major obvious subsystems that may be affected by oil production and related activities are mentioned. If the purpose of the Statement is to list and briefly discuss these potential problem areas, then it is satisfactory. However, we feel the Statement should discuss the relative importance of the systems potentially affected to the continued existence of a balanced marine ecosystem, and what effect degradation of the separate subsystems by oil related activities would have on the system as a whole and the potential losses to other users of the marine ecosystem.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

A good description of the various types of offshore oil and gas drilling vessels was presented (Chapter 1, part c), but it would be more advantageous to summarize with estimates of: (a) the number of each type of craft that may be required for various future levels of exploration; (b) the cost of each type of vessel; (c) the advantages and/or disadvantages of each type of rig; and (d) the DOI leasing schedule, where these vessels would be used and in what quantity.

We feel that Chapter 2 should have a more extensive bibliography, and it should show some specific relationship to the Administration's task of evaluating what marine environmental aspects will be impacted by OCS exploration and extraction activities.

Thank you for the opportunity to transmit these comments at this time.

Sincerely,

W. H. Pennington
Office of the Assistant Administrator
for Environment and Safety

cc: CEQ (5)

Energy Research and Development Administration (ERDA)

As a result of a request for an extension of the comment period ERDA submitted comments on the DEIS by letter dated September 8, 1975. The comments were, in the most part, general in nature and are responded to beginning with paragraph three as follows:

Page l, para. 3 - By rewriting and/or revising many of the Chapters and sections it is believed that the final EIS no longer carriers a permissive attitude toward low level chronic discharges of petroleum and drilling chemicals.

Page l, para. 4 - The restructured Chapter III, together with the original Appendix A, now provide a more complete description of the effects of oil to the marine ecosystem as a whole which reflects the intent of the comment.

Page 2, para. 5 - This comment contains four parts - (a) thru (d) and are responded to in that order as follows:

(a) The numbers of each type of drilling vessel constructed or comtemplated under the Title XI Program is now included in Chapter I.

(b) The cost of each individual unit has not been broken down, however, the total cost for each design group has been included in Chapter I.

(c) The advantages and/or disadvantages of each type of rig are believed to be adequately described in Chapter I. The type of rig to be constructed is based on the anticipated service over the lifetime of the rig.

(d) To include the DOI leasing schedule and where and how many Title XI vessels would be used is not considered pertinent information when the nature of the Title XI Program is only to guarantee the construction loan. However, Chapter II has been revised to indicate the environment in which the vessels will, or could, operate.

Page 2, para. 6 - Additional references have been added to Chapter II and, it is believed that the rewritten Chapter III responds to the comment regarding marine environmental aspects.

CLAIRE T. DEDRICK
SECRETARY

Department of Conservation
Department of Fish and Game
Department of Navigation and
Ocean Development
Department of Parks and Recreation
Department of Water Resources

EDMUND G. BROWN JR.
GOVERNOR OF
CALIFORNIA

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Air Resources Board
Colorado River Board
San Francisco Bay Conservation and
Development Commission
Solid Waste Management Board
State Lands Commission
State Reclamation Board
State Water Resources Control Board
Regional Water Quality Control Boards

THE RESOURCES AGENCY OF CALIFORNIA
SACRAMENTO, CALIFORNIA

AUG 29 1975

Mr. George C. Steinman
U. S. Department of Commerce
Maritime Administration
Washington, D. C. 20230

Dear Mr. Steinman:

The State of California has reviewed the "Draft Environmental Impact Statement, Maritime Administration, Title XI, Vessels Engaged in Offshore Oil and Gas Drilling Operations (MA-EIS-7302-75022-D)", undated, which was submitted to the Office of Planning and Research (State Clearinghouse) within the Governor's Office. The review was coordinated with the Departments of Conservation, Transportation, Health, Fish and Game, Parks and Recreation, and Water Resources; the Air Resources Board; the State Water Resources Control Board; The Reclamation Board; the San Francisco Bay Conservation and Development Commission; the Solid Waste Management Board; and the California Coastal Zone Conservation Commission. Our comments on the draft statement are set forth below.

<u>California Coastal Zone Conservation Commission Concerns</u>

The Commission staff has two general comments which are discussed below.

1. While the biological setting and impact sections appear to be thorough, social setting and impact are completely ignored. Clearly, facilitating the availability of additional oil and gas has an impact upon a society and world which uses such resources. In particular, we would suggest that the final EIS more adequately assess the cumulative effects of resource depletion on a national as well as global scale, and the growth-inducing impacts upon society of increasing resource use, which this project would facilitate. A discussion of global social impact, while perhaps seemingly trivial, is actually essential, as the DEIS states that the new vessels may operate in any ocean in the world, and it is a fact that the United States currently uses over fifty percent (50%) of the world's resources.

2. A more thorough discussion of alternatives, without regard to the sponsor's authority or jurisdiction, is needed. Of course, alternatives to the proposed action, including, where relevant, those not within the existing authority of the responsible agency should be rigorously explored and objectively evaluated. In particular, the alternatives of energy conservation and development of other energy sources should be further explored.

Department of Parks and Recreation Concerns

The Draft Environmental Impact Statement is not restrictive enough to enforce improvements in the handling of oil by vessels engaged in offshore oil and gas drilling operations.

The report includes tables showing the results of oil spills in the past, and indicates that we can expect the same in the future with possibly greater frequency in overall magnitude due to increased oil drilling activity. We would like to believe that with more stringent controls pollution could and should be reduced even with a greater number of wells drilled.

It has been recognized by the California Coastal Commission that we have multiple uses of the resources found along our coastal shoreline, and that the use of one resource should not have detrimental effects on other uses. This would apply to the potential oil pollution conflict with our many state beaches and parks and the recreation they provide. The involvement here is not only with people, but also the effect an oil pollution accident would have on the wildlife that inhabits these areas. In this respect we recommend the inclusion on page IV-1 of the following regulations as mitigation measures:

1. No oil facilities constructed under Title XI will be located off the California coast within 6 miles of designated Areas of Special Biological Significance or habitats of rare or endangered species;

2. Produced formation waters shall be reinjected into the oil production zone. Exceptions shall be granted only when the lease holder can provide adequate data to indicate the waste does not indicate acute or chronic toxicity to representative resident species of aquatic organisms;

3. Waste discharge to marine water shall not exceed 15 ppm of oil in water.

Fish and Wildlife Concerns

The Department of Fish and Game has several general comments which are discussed below. Attachment No. 1 contains comments which are to be considered as an integral part of the State's comments.

The Department finds that the draft EIS is inadequate and presents a funding proposal that would lead to practices which increase the probability of oil spills, and which, therefore, would be in conflict with various federal and state agencies' policies and regulations. However, should the recommendations detailed in our response to specific sections be incorporated and thereby become recommendations of the Department of Commerce, particularly the section on mitigation measures, we would find the proposal minimally acceptable.

The data presented in Tables IIIA-4, A-5, A-6 and page VI-1 clearly details that pollutants will be discharged into the marine environment. Such discharges would be in conflict with the intent of other agencies such as described in the regulatory concepts of Section 10(a) of the Deepwater Port Act of 1974 (P.L. 93-627), and the Department of the Interior's Environmental Impact Statement and Senate Joint Review of the Deepwater Port Act.[1/] The former regulation indicates that "Regardless of relative merits, the occurrence of oil spills in offshore regions remains unacceptable, both economically and environmentally." The latter indicates, in part, "the Act empowers the Secretary of Transportation to prescribe regulations . . . required, (a) to prevent pollution of the marine environment."

The EIS also appears to conflict with State of California interests. The EIS should recognize that California coastal resources are considered to be limited and in need of protection and that meeting the many needs will require close coordination of various interests. The Preliminary Coastal Plan of the California Coastal Zone Conservation Commission indicates that "the essence of the plan is that the coast should be treated not as ordinary real estate but as a unique place, where conservation and special kinds of development should have priority." The plan goes on to indicate, in part, that "energy installations allowed on the coast must be subject to stringent environmental safeguards." The EIS should recognize and address these concepts.

1/ Draft Environmental Impact Statement for Deepwater Port Regulations, Department of Transportation, U. S. Coast Guard, Deepwater Port Project, Office of Marine Environment and Systems, Washington D. C. 20590, 6 Jan. 1975.

In contrast to the main body of the report, the sections on General Description of the Marine Environment as well as Appendix A, regarding the harmful effects of oil pollution, are very good. We see value in rewriting the report in the style of those sections in order to avoid what appears to be a project-justification approach presenting inadequate supporting data. Heavy emphasis, for example, is placed on the capabilities of "one major builder" without reference or data indicating the capabilities of the industry as a whole, the "average builder" or the range of capabilities of all builders.

Oil and Gas Concerns

The State Division of Oil and Gas has a number of specific comments which are included as Attachment No. 2. These comments are to be considered as an integral part of this letter.

Recommendation

It is recommended that the final statement respond to the concerns and include the views set forth in these comments.

Thank you for the opportunity to review and comment on the draft statement.

Sincerely,

L. Frank Goodson

for Secretary for Resources

Attachments
Air Mail
cc: Director of Management Systems
State Clearinghouse
Office of Planning and Research
1400 Tenth Street
Sacramento, California 95814
(SCH No. 75051942)

Attachment No. 1

Specific Comments on the
Draft Environmental Impact Statement
Maritime Administration, Title XI
Vessels Engaged in Offshore Oil and Gas
Drilling Operations (MA-EIS-7302-75022-D)

By Department of Fish and Game, State of California

The following comments refer to specific items of the draft environmental impact statement.

1. Page I-13. A description of the type structure and an evaluation should be made of the 945-foot platform planned for EXXON in federal waters off Santa Barbara, California. This type of structure could become common off the California area influencing effects of offshore drilling on the marine environment.

2. Page II-7, last paragraph. A good example of an upwelling area, and its effects on world fisheries, occurs in the proposed offshore drilling area off California. The report should elaborate on this and the importance of the Northern anchovy, Engraulis mordax, fishery and possible adverse effects of oil spills upon larval fish in the area.

Larval fish and eggs occur near the surface in the pelagic waters off California. Appendix A indicates toxic fractions of oil are accommodated by sea water and persist in the water column, whereas heavy oils form surface slicks. The data also indicate larval fish, as well as the small pelagic fish tested were generally more susceptible to low concentrations of oil. The report should elaborate on this subject.

3. Page III-3, second complete paragraph, last sentence. This statement should recognize that toxic agents have been used to increase fluidity of drilling mud and that these should not be discharged as toxic waste.

4. Page III-8, first complete paragraph. Same comment as page III-3.

5. Page III-10, first complete paragraph, first sentence. This statement dismisses the fact that most pollution incidents are avoidable and a large percentage are intentional or a result of negligence.

6. Page III-24, third complete paragraph. Same comment as page III-3.

7. Page III-62, second paragraph. Change the first sentence to read as follows: Erosion of the shoreline may be considerable <u>unless</u> the runoff is controlled by installations such as <u>vegetative ground cover</u>, concrete or steel bulkheads . . . . (addition underlined). Vegetative ground cover has been effectively employed in California to prevent erosion from project areas <u>during</u> the period of construction. This is effective in localities having extended dry periods without rainfall followed by a short rainy season.

8. Page III-71, second paragraph, third sentence, should include anchovy as an important resident species in place of lingcod which appears in the report as "lingood." The "little" tuna should not be included as a migratory species for California. It is not clear if this sentence represents important commercial fish landed in California or the United States. The information, as corrected, would represent California fish landings.

9. Page IV-1. Mitigation Measures. We recommend inclusion of the following regulations as mitigation measures:

> To better assure prevention and control oil spills: (1) no oil facilities constructed under Title XI will be located off the California coast within 6 miles of designated Areas of Special Biological Significance or habitats of rare or endangered species; (2) produced formation waters shall be reinjected into the oil production zone. Exceptions shall be granted only when the lease holder can provide adequate data to indicate the waste does not exhibit acute or chronic toxicity to representative resident species of aquatic organisms; (3) wastes discharged to marine waters shall not exceed 15 ppm of oil in water.

These requirements are necessary to protect living marine resources. The data contained in Appendix A indicates the lighter fractions of oil can disperse from a surface layer of oil into the underlying waters. These light fractions are also the more toxic components of crude oil. Tests (page A-10, Table 5) indicate the water soluble fraction of crude oil killed 50 percent of a test population of Mysids (a shrimplike animal) when the oil exceeded 8.7 ppm oil in water. Also the Water Quality Objectives of the Water Quality Control Plan for Ocean Waters of California as well as the Fish and Game Code would be violated should visable oil enter the State's waters from project facilities.

Attachment No. 2

Specific Comments on the
Draft Environmental Impact Statement
Maritime Administration, Title XI
Vessels Engaged in Offshore Oil and Gas
Drilling Operations (MA-EIS-7302-75022-D)

By Division of Oil and Gas
Department of Conservation, State of California

The following comments refer to specific items of the draft environmental impact statement.

1. Page I-5, Table 1-1. The table should show the numbers of wells in each category drilled by the program vessels.

2. Page I-6, Section C. The approximate costs of all types of program vessels should be given. Portions of this section appear to be taken from other sources; if so, the sources should be identified.

3. Pages I-53 and I-54, paragraph 5. Many workover operations are not mentioned. To avoid an exhaustive treatment of the subject, a very brief and general summary should suffice.

4. Pages I-59 and I-60, paragraph 6b. If U.S.C.G. regulations do not apply to vessels of less than 300 gross tons, this should be mentioned in relation to the voluntary compliance with U.S.C.G. regulations.

5. Pages II-11 and II-12. Not all of the shelves are dammed. Most of the California shelf north of the Santa Barbara Channel is not dammed.

6. Page II-14. Many other submarine or drowned subaerial features of deltas, such as prodeltas, island arcs, distributary channels, and interdelta plains are worth mentioning.

7. Chapter III, Introduction and Section A. The relationships between the proposed project and the impacts of the increased oil activity should be fully explained in terms of probable increase of impact caused by the project. Because some of the impacts, such as tanker spills, are far removed in time and sequence from the proposed project, the degree of removal should also be stated.

The primary source of environmental impacts is not stated, and this omission makes full understanding of "Subchapter A" difficult. If the primary effect of the proposed project is increased construction of drilling and service vessels, then the increased construction and, possibly, increased use of the vessels in U. S. waters would be the primary sources of environmental impact, and the primary

impacts would be from construction of the vessels (III.B.5), from the vessels' being on location (III.A.19), from drilling (III.A.), and from pipe laying (III.B.3). Other sources and impacts, such as those from production (particularly platform production), and transportation, should be considered as secondary.

8. Page III-1, Table III A.1. The hydrocarbons in this table should be called "resources", not "reserves", unless their economically feasible producibility has been proven. It is not clear whether this table refers to possible total hydrocarbons in place or to possible recoverable hydrocarbons.

9. Pages III-3 through III-8. The section on blowouts is not clear.

10. Page III-11, Section A.2. Drilling accidents should be separated from production and transportation accidents.

11. Page III-13, Section A.3. Note that none of the spills in this section are labelled as originating from a drilling or service vessel.

12. Page III-16, Section A.4. None of the spills in this section originate from a drilling or service vessel. The second sentence is unclear, but a 500 million barrel find is not "medium" in California, and probably not in the United States.

13. Page III-18, Section A 5. None of the spills in this section originate from a drilling or service vessel.

14. Page III-22, Section A.6. None of the spills in this section are labelled as originating from a drilling or service vessel.

15. Page III-25, etc., Sections A.8-A.18. All of these sections deal with oil spills. As noted above, a direct link between oil spills and the construction of drilling or service vessels has not been established in this report.

16. Page IV-29, Section H. The first offshore drilling was at Summerland field in California in 1896.

17. Page V-1, Section A. Even if the U. S. offshore program were terminated, there would still be a demand for drilling and large service vessels overseas.

State of California

The State of California by letter dated June 25, 1975 requested an extension of time for submittal of comments until August 21, 1975.

The Resources Agency of California letter of August 29, 1975, submitted comments from four agencies. The large majority of these comments deal with subjects that apply only to oil and gas development of the outer continental shelf and are properly addressed by the Department of the Interior at the time environmental impact statements are prepared by that department for oil and gas leasing on the outer continental shelf.

Response to the comments, however, are made as follows:

California Coastal Zone Conservation Commission Concerns

Page 1, para. 1 - To include a discussion on global social impact as a result of the improbable use of Title XI rigs conducting exploratory drilling in other parts of the world would be an overwhelming task and the results unreliable and meaningless in an EIS such as this.

Page 2, para. 2 - Chapter V has been revised and now incorporates the main issues of this comment.

Department of Parks and Recreation Concerns

Page 2, para. 1 - Comment is considered as an opinion and is not specific enough for a detailed response.

Page 2, para. 2 - More stringent controls to prevent oil spills are contained in the May 1975 report "An Analysis of the Feasibility of Separating Exploration from Production of Oil and Gas on the Outer Continental Shelf" by the Congress of the United States - Office of Technology Assessment.

Page 2, para. 3 - The following numbered paragraphs are responded to:

1. - Oil facilities are not constructed under the Title XI program.

2. - This EIS is not a regulatory vehicle and, therefore, cannot impose either existing or proposed regulations. Regulations for oil and gas drilling operations are under the auspices of the Department of the Interior.

3. - Response to paragraph No. 2 above also applies to this comment.

Fish and Wildlife Concerns

Pages 3 and 4 - The Fish and Game Department's general comments are concerned with the possibility that Title XI vessels may conflict with state and federal regulations and policies, thereby increasing the risk of oil pollution. The contrary to this concept is the case, however, because not only are the vessels constructed to rigid standards established by the regulatory bodies, but when they become operational must comply with all state and federal regulations, laws and policies that apply to oil and gas exploration of the outer continental shelf.

Regarding comment on page 4 relative to "one major builder, it is believed this has reference to the description of the various types of drilling vessels contained in Chapter I. It is not the intent, or the belief that Chapter I emphasizes one owner but describes typical drilling vessels in which Title XI applications have been, or could be, received for construction loan guarantees.

Attachment No. 1

Page l, para. 1 - The EIS applies only to floating drill vessels and not fixed production platforms.

Page 1, para. 2 - Chapter II has been revised to reflect the comment relative to Northern anchovy.

Page 1, para. 3 - Chapter III has been completely revised and now reflects the comment relating to the discharge of drilling mud.

Page 1, para. 4 - Response to paragraph 3 above applies to this comment.

Page 1, para. 5 - Chapter III has been completely revised and reflects the more stringent standards regarding intentional discharges.

Page 1, para. 6 - Response to paragraph 3 applies to this comment.

Page 2, para. 7 - Comment is valid and Chapter III, page III- 80 reflects the change.

Page 2, para. 8 - In restructuring Chapter III it was found necessary to completely replace the section on commercial and sport fishing. Beginning on page III- 67 the new section is entitled "Impacts on Commercial and Sport Fisheries" and addresses California along with other coastal states.

Page 2, para. 9 - Response to these comments relative to regulations has been made on page IV-15.

Attachment No. 2

Page 1, para. 1 - Table 1-1 has been replaced by a more meaningful table in which this comment would not apply.

Page 1, para. 2 - Costs have been included and portions of Chapter I have been rewritten.

Page 1, para. 3 - The comment states that many workover operations are not mentioned but does not state what is lacking. It is felt that the workover operations are adequately described.

Page 1, para. 4 - Page I-43 has been revised to reflect this comment.

Page 1, para. 5 - Page II-7 has been revised to reflect this comment.

Page 1, para. 6 - The section on drowned valley's etc., has been deleted as extraneous material not considered pertinent to an EIS of this nature.

Page 1, para. 7 - Chapter III has been entirely restructured and now reflects the majority of the issues contained in the comments.

Page 2, para. 8 - Table IIIA-1 has been removed.

Page 2, para. 9 - The section on blowouts has been rewritten and clarified.

Page 2, para. 10, 11, 12, 13 and 14 - The statement attempts to address both direct primary and direct secondary effects of OCS oil and gas drilling operations. The effects of development, production, transportation, and storage can be considered direct secondary effects.

Page 2, para. 15 - Chapter III has been completely revised. The effects and behavior of crude oil in the marine environment are independent of source.

Page 2, para. 16 - Page IV-20 has been revised to reflect this comment.

Page 2, para. 17 - Comment is concurred in however, where Title XI vessels are concerned the program would be terminated.

STATE OF FLORIDA

Department of Administration

Division of State Planning

660 Apalachee Parkway - IBM Building

TALLAHASSEE

32304

(904) 488-2371

Earl M. Starnes
STATE PLANNING DIRECTOR

Reubin O'D. Askew
GOVERNOR

Lt. Gov. J. H. "Jim" Williams
[redacted]
SECRETARY OF ADMINISTRATION

June 30, 1975

United States Department of Commerce
Maritime Administration
Environmental Activities Group
Washington, D. C. 20230

Dear Sir:

Functioning as the state planning and development clearinghouse contemplated in U. S. Office of Management and Budget Circular A-95, we have reviewed the following draft environmental impact statement:

> Maritime Administration Title XI, Vessels Engaged in Offshore Oil and Gas Drilling Operations MA-EIS-7302-75022D
>
> SAI: 75-1792 E

During our review we referred the environmental impact statement to the following agencies, which we identified as interested: Department of Natural Resources, Board of Trustees of the Internal Improvement Trust Fund, Department of Pollution Control, Game and Fresh Water Fish Commission, and Department of Transportation. Agencies were requested to review the statement and comment on possible effects that actions contemplated could have on matters of their concern. Based on the review of the interested state agencies, the Florida Clearinghouse has no adverse comments on this statement.

In accordance with the Council on Environmental Quality guidelines concerning statement on proposed federal actions affecting the environment, as required by the National Environmental Policy Act of 1969, and U. S. Office of Management and Budget Circular A-95, this letter, with attachments, should be appended to the final environmental impact statement on this project. Comments regarding this statement and project contained herein or attached hereto should be addressed in the statement.

We request that you forward us copies of the final environmental impact statement prepared on this project.

Sincerely,

Ed Maroney

E. E. Maroney, Chief
Bureau of Intergovernmental Relations

EEM/K/dt
cc: Mr. J. Landers
Mr. W. N. Lofroos
Mr. Harmon Shields
Dr. Tim Stuart
Mr. Estus Whitfield
Mr. Walter Kolb

STATE OF FLORIDA

Department of Administration

Division of State Planning

660 Apalachee Parkway - IBM Building

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Earl M. Starnes
STATE PLANNING DIRECTOR

Reubin O'D. Askew
GOVERNOR

Lt. Gov. J. H. "Jim" Williams
SECRETARY OF ADMINISTRATION

June 13, 1975

Mr. Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs
Department of Commerce
Washington, D. C. 20230

Dear Mr. Galler:

Subject: Draft Environmental Impact Statement Prepared by the Department of Commerce for the Maritime Administration Title XI - Vessels Engaged in Offshore Oil and Gas Drilling Operations

Due to the June 16 deadline for receiving comments on the above-referenced EIS, I am submitting my comments directly to your office.

I recommend the option "3. MODIFY THE PROGRAM," as it appears on V-4. This approach will not negate the potential for development of a significantly increased U. S. merchant marine and offshore drilling capability, and will at the same time make appropriate concessions to the importance for environmentally "sound" offshore drilling vessels. It appears that it is appropriate for the MarAd program to attempt to devise environmental standards above and beyond those presently required. If such an attempt appears to be ineffective or unduly restrictive to a reasonable level of development, it can be discontinued. Minimally, it will emphasize the importance of environmental concern in the development and construction of such vessels. Option "(a)" on V-4 does not appear to be a realistic alternative at this time.

Thank you for this opportunity to comment.

Sincerely,,

James I. Jones

James I. Jones, Ph.D.
Special Projects Officer
Division of State Planning
and
Science Advisor to the Governor

JIJ/bj

State of Florida

The Department of Administration submitted a comment pertinent to modifying the program on page V-4. As a result of a similar comment received from the Department of the Interior and others this alternative has been completely removed.

Office of Planning and Budget

Executive Department

James T. McIntyre, Jr.
Director

G E O R G I A   S T A T E   C L E A R I N G H O U S E   M E M O R A N D U M

TO: Mr. George C. Steinman, Chief
Environmental Activities Group
U. S. Department of Commerce
Maritime Administration
Washington, D. C. 20230

FROM: Charles H. Badger, Administrator
Georgia State Clearinghouse
Office of Planning and Budget

DATE: June 19, 1975

SUBJECT: RESULTS OF STATE-LEVEL REVIEW

Applicant: Department of Commerce, Maritime Administration

Project: Draft Environmental Impact Statement (oil and gas drilling)

State Clearinghouse Control Number: 75-05-08-10

The State-level review of the above-referenced draft environmental statement has been completed. This project is recommended for further development with the following recommendations for strengthening the project:

P. II-9 There are beaches used for Loggerhead Turtle rookeries all along the South Atlantic coast, and especially on the barrier islands off Georgia's coast.

P. III-2 ...harmful impacts are the unavoidable result of routineoperations...

Efforts should be made to at least minimize, if not avoid as may of the impacts of the normal operations as possible.

There should be a concerted effort to identify the effects of as many of the operations of OCS development as possible and to develop mitigation measures. If no mitigation is possible then OCS development should be suspended pending increases in technology which will enable mitigation measures to be developed.

The following State agencies have been offered the opportunity to review and comment on this project:

270 Washington St., S. W. • Atlanta, Georgia 30334

Permit

CORPS OF ENGINEERS

Date: May 22, 1975

Department of Commerce
Maritime Administration
Washington, D. C.

FROM: Name: Lorene Blue

Title: A-95 Review Coordinator

Regional Clearinghouse: Coastal APDC

SUBJECT: PROJECT NOTIFICATION AND REVIEW

Applicant: Department of Commerce

Project: Draft EIS Vessels Engaged in Offshore Oil and Gas Drilling Operations
State Clearinghouse Control Number: 75-05-08-10

Regional Clearinghouse Staff Contact: Lorene Blue

The Regional Clearinghouse has reviewed the Summary Notification for the above project.

As a result of the review it has been determined that the proposed project is in accord with regional and local plans, programs and objectives as of this date.

If you have any questions, please contact the clearinghouse staff member named above, who will be pleased to assist you.

Comment:

Copy to State Clearinghouse

State of Georgia
BUREAU OF STATE PLANNING AND COMMUNITY AFFAIRS

Form RC-A95-4
(May 70)
SPB-70-4-70

Georgia Department of Natural Resources, inclusive of historical and archaeological sections

Office of Planning and Budget, Executive Department

cc: Ray Siewert, DNR
Gary Midkiff, OPB

Enclosure: Review comments prepared by the Coastal Area Planning and Development Commission dated May 22, 1975

State of Georgia

The Georgia State Clearinghouse submitted comments relative to Chapters II and III. Disposition of the comments are as follows:

Page II-9 has been revised to include the use of beaches by Loggerhead Turtles. (New page II-5).

Page III-2 - The comments relative to harmful impacts being the unavoidable result of routine operations are noted. These unavoidable impacts are more thoroughly discussed in the restructured version of Chapter III.

MARYLAND
DEPARTMENT OF STATE PLANNING
301 WEST PRESTON STREET
BALTIMORE, MARYLAND 21201
TELEPHONE: 301-383-2451

MARVIN MANDEL
GOVERNOR

VLADIMIR A. WAHBE
SECRETARY OF STATE PLANNING
MADELINE L. SCHUSTER
DEPUTY SECRETARY

June 16, 1975

Mr. George C. Steinman, Chief
Environmental Activities Group
U. S. Maritime Administration
Washington, D. C. 20230

SUBJECT: DRAFT ENVIRONMENTAL IMPACT STATEMENT REVIEW

Applicant: U. S. Maritime Administration

Project: Draft EIS - Vessels Engaged in Offshore Oil & Gas Drilling Operations

State Clearinghouse Control Number: 75-5-782

State Clearinghouse Contact: Warren D. Hodges (383-2467)

Dear Mr. Steinman:

The State Clearinghouse has reviewed the above project. In accordance with the procedures established by the Office of Management and Budget Circular A-95, the State Clearinghouse received comments (copies attached) from the following:

Department of Economic & Community Development, Energy Policy Office, Environmental Health Administration and our staff: noted that the Statement appears to adequately cover those areas of interest to their agencies.

Department of Natural Resources: commented that the oil spill contingency plans should direct that the containment boom be at the drill location at all times rather than several miles away.

Tri-County Council for Southern Maryland: indicated that insufficient emphasis is placed on routine preventive procedures; such as, the deployment of the containment booms during appropriate phases of drilling and transfer operations. Also, some attention should be given to the types of emergency equipment which should be kept aboard a drilling rig and to the adequacy of training in clean-up procedures provided to drilling rig personnel.

We hope the above comments will be useful in the development of the final EIS and we look forward to continued cooperation with your agency.

Sincerely,

Vladimir Wahbe

Att.
cc: Jerold Gettleman
Bernard Payne
Donald Noren
Paul McKee
Gerald McKinney

Maryland Department of State Planning
State Office Building
301 West Preston Street
Baltimore, Maryland 21201 Date: 5/19/75

DEPT. OF STATE PLANNING
RECEIVED
MAY 22 1975
REVIEWED
ANSWERED

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT REVIEW

Applicant: U. S. Maritime Administration

Project: Draft EIS - Vessels Engaged in Offshore Oil and Gas Drilling Operations

State Clearinghouse Control Number: 75-5-782

We have reviewed the above draft environmental impact statement and our comments as to the adequacy of treatment of physical, ecological, and sociological effects of concern are shown below:

	Check (X) for each item: None	Comment enclosed
1. Additional specific effects which should be assessed:	X	
2. Additional alternatives which should be considered:	X	
3. Better or more appropriate measures and standards which should be used to evaluate environmental effects:	X	
4. Additional control measures which should be applied to reduce adverse environmental effects or to avoid or minimize the irreversible or irretrievable commitment of resources:	X	
5. Our assessment of how serious the environmental damage from this project might be, using the best alternative and control measures:	\	
6. We identify issues which require further discussion of resolution as shown:	X	

Signature [signature]

Title Director

Agency Community Dev. Adm.
Dept. of Economic and Community Dev.

Maryland Department of State Planning
State Office Building
301 West Preston Street
Baltimore, Maryland 21201 Date: 6/3/75

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT REVIEW

Applicant: U. S. Maritime Administration

Project: Draft EIS - Vessels Engaged in Offshore Oil and Gas Drilling Operations

State Clearinghouse Control Number: 75-5-782

We have reviewed the above draft environmental impact statement and our comments as to the adequacy of treatment of physical, ecological, and sociological effects of concern are shown below:

	Check (X) for each item	
	None	Comment enclosed
1. Additional specific effects which should be assessed:	X	
2. Additional alternatives which should be considered:	X	
3. Better or more appropriate measures and standards which should be used to evaluate environmental effects:	X	[illegible]
4. Additional control measures which should be applied to reduce adverse environmental effects or to avoid or minimize the irreversible or irretrievable commitment of resources:		Our concerns are mainly in two areas. (1) Oil spills and (2) its affect on marine life.
5. Our assessment of how serious the environmental damage from this project might be, using the best alternative and control measures:	✓	
6. We identify issues which require further discussion of resolution as shown:	X	

Signature [illegible]

Title Planner

Agency [illegible]

Maryland Department of State Planning
State Office Building
301 West Preston Street
Baltimore, Maryland 21201 Date:

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT REVIEW

Applicant: U. S. Maritime Administration

Project: Draft EIS - Vessels Engaged in Offshore Oil and Gas Drilling Operations

State Clearinghouse Control Number: 75-5-782

We have reviewed the above draft environmental impact statement and our comments as to the adequacy of treatment of physical, ecological, and sociological effects of concern are shown below:

	Check (X) for each item: None	Check (X) for each item: Comment enclosed
1. Additional specific effects which should be assessed:	X	
2. Additional alternatives which should be considered:	X	
3. Better or more appropriate measures and standards which should be used to evaluate environmental effects:	X	
4. Additional control measures which should be applied to reduce adverse environmental effects or to avoid or minimize the irreversible or irretrievable commitment of resources:	X	
5. Our assessment of how serious the environmental damage from this project might be, using the best alternative and control measures:	X	
6. We identify issues which require further discussion of resolution as shown:	X	

Signature S H Ellingson

Title Environmental Health

Agency [illegible]

Maryland Department of State Planning
State Office Building
301 West Preston Street
Baltimore, Maryland 21201

Date: 6/2/75

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT REVIEW

Applicant: U.S. Maritime Administration

Project : Draft EIS - Vessels Engaged in Offshore Oil and Gas Drilling Operations

State Clearinghouse Control Number: 75-5-782

We have reviewed the above draft environmental impact statement and our comments as to the adequacy of treatment of physical, ecological, and sociological effects of concern are shown below:

	Check (X) for each item	
	None	Comment enclosed
1. Additional specific effects which should be assessed:	X	
2. Additional alternatives which should be considered:	X	
3. Better or more appropriate measures and standards which should be used to evaluate environmental effects:	X	
4. Additional control measures which should be applied to reduce adverse environmental effects or to avoid or minimize the irreversible or irretrievable commitment of resources:		X
5. Our assessment of how serious the environmental damage from this project might be, using the best alternative and control measures:	X	
6. We identify issues which require further discussion of resolution as shown:	X	

Signature [illegible]

Title [illegible]

Agency [illegible]

COMMENTS ON STATE CLEARINGHOUSE PROJECT NO. 75-5-782
DRAFT EIS - Vessels Engaged in Offshore Oil and Gas Drilling Operations

The Department of Natural Resources has reviewed this project and wishes to make the following comment:

The statement regarding oil spill contingency plans should indicate that the containment boom should be at the drill location at all times rather than several miles away from the site.

Maryland Department of State Planning
State Office Building
301 West Preston Street
Baltimore, Maryland 21201

Date: May 27, 1975

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT REVIEW

Applicant: U. S. Maritime Administration

Project: Draft EIS - Vessels Engaged in Offshore Oil and Gas Drilling Operations

State Clearinghouse Control Number: 75-5-782

We have reviewed the above draft environmental impact statement and our comments as to the adequacy of treatment of physical, ecological, and sociological effects of concern are shown below:

	Check (X) for each item: None	Comment enclosed
1. Additional specific effects which should be assessed:		Insufficient emphasis on routine procedures e.g. feasibility of including deployment of containment booms during appropriate phases of drilling and/or transfer operations.
2. Additional alternatives which should be considered:		
3. Better or more appropriate measures and standards which should be used to evaluate environmental effects:		
4. Additional control measures which should be applied to reduce adverse environmental effects or to avoid or minimize the irreversible or irretrievable commitment of resources:		No mention is made of emergency equipment to be kept aboard drilling rig, or training of personnel in "clean-up" procedures.
5. Our assessment of how serious the environmental damage from this project might be, using the best alternative and control measures:		
6. We identify issues which require further discussion of resolution as shown:		

Signature [signature]

Title Executive Director

Agency Tri-County Council for Southern Maryland

State of Maryland

The Department of State Planning submitted comments received by the State Clearing House from various agencies which primarily deal with the provision of emergency equipment on board the drilling rig and the training of personnel in clean-up procedures. The comments are responded to as follows:

The U.S. Department of the Interior, OCS Order No. 7, sets forth the requirements governing Pollution and Waste Disposal for operators of drilling and production units. OCS Order No. 7 specifies the corrective action to be taken in the event of an oil spill and the type and location of standby pollution control equipment.

Under the provisions of the Title XI loan guarantee program it is only required that an applicant comply with all applicable laws and regulations covering the construction and operation of the vessel. The environmental impact statement reflects this requirement and cannot incorporate additional operating procedures over and above those established by the Regulatory Agencies.

AN EQUAL OPPORTUNITY EMPLOYER

EXECUTIVE DEPARTMENT

INTERGOVERNMENTAL RELATIONS DIVISION

240 COTTAGE STREET S.E. • • • • SALEM, OREGON 97310

ROBERT W. STRAUB
GOVERNOR

STAFFORD HANSELL
Director

June 17, 1975

Mr. Sidney R. Galler
Deputy Asst. Secretary for
Environmental Affairs
Department of Commerce
Washington, D.C. 20230

Dear Mr. Galler:

Re: Vessels Engaged in Offshore Oil and Gas Drilling Operations - Draft Environmental Impact Statement PNRS #7505 4 260

Thank you for submitting your draft Environmental Impact Statement for State of Oregon review and comment.

Your draft was referred to the appropriate state agencies. The State Department of Geology and Mineral Industries offered the enclosed comments which should be addressed in the preparation of your final Environmental Impact Statement.

We will expect to receive copies of the final statement as required by Council of Environmental Quality Guidelines.

Sincerely,

William H. Young

William H. Young
Administrator

WHY:lm

Enclosure

OREGON PROJECT NOTIFICATION AND REVIEW SYSTEM

STATE CLEARINGHOUSE

Local Government Relations Division
240 Cottage Street S.E., Salem, Oregon 97310
Ph: 378-3732

RECEIVED-PTLD
MAY 21 1975
DEPT OF GEOLOGY

PNRS STATE REVIEW

Project #: 7505 4 261 Return Date: JUN 1975

ENVIRONMENTAL IMPACT REVIEW PROCEDURES

1. A response is required to all notices requesting environmental review.
2. OMB A-95 (Revised) provides for a 30-day extension of time, if necessary. If you cannot respond by the above return date, please call the State Clearinghouse to arrange for an extension.

ENVIRONMENTAL IMPACT REVIEW
DRAFT STATEMENT

( ) This project does not have significant environmental impact.

( ) The environmental impact is adequately described.

(X) We suggest that the following points be considered in the preparation of a Final Environmental Impact Statement regarding this project.

( ) No comment.

\- - - - - - - - - -

REMARKS

1. In describing the possible impact of the proposed development no reference was made to the 25 years of experience in the Gulf Coast area. What long term effects of development have been experienced there?

2. No discussion is made of the main alternative to increased OCS development - foreign imports. Overwater transport is 10 times more likely to contribute to pollution than is the drilling and producing activity. There are no other alternatives for the next 10 years at least.

3. Restrictions should be imposed for development in estuaries or breeding grounds for rare species.

4. There is no consideration given aesthetic values in sensitive areas.

Agency Geology By V. C. Newton

AN EQUAL OPPORTUNITY EMPLOYER

EXECUTIVE DEPARTMENT

INTERGOVERNMENTAL RELATIONS DIVISION

~~LOCAL GOVERNMENT RELATIONS DIVISION~~

240 COTTAGE STREET S.E. • • • • SALEM, OREGON 97310

ROBERT W. STRAUB
GOVERNOR

STAFFORD HANSELL
Director

June 23, 1975

Mr. Sidney R. Galler
Deputy Asst. Secretary
for Environmental Affairs
Department of Commerce
Washington, D. C. 20230

Dear Mr. Galler:

Re: Vessels Engaged in Offshore Oil And Gas Drilling Operations - Draft Environmental Impact Statement
PNRS #7505 4 260

The State Clearinghouse has received additional comments suggesting areas for improvement on the Oil and Gas Drilling Operations project draft Environmental Impact Statement subsequent to our June 17, 1975 letter. The Department of Environmental Quality commented as follows:

> The Draft EIS is OK as a general information report; however, much more specific data would be needed to properly evaluate specific operational sites.

Please consider this letter as an addendum to our previous letter.

Sincerely,

William H. Young

William H. Young
Administrator

WHY:ls

State of Oregon

The State of Oregon submitted comments on the draft environmental impact statement to the effect that more specific data is needed, also the Geology Agency submitted four specific comments.

The general comment that more specific data is needed has been resolved by rewriting and restructuring some of the chapters for the final EIS. Disposition of the four Geology Agency comments are as follows:

Comment 1

Chapter III addresses the comment in that experience has shown that no long term adverse environmental effects have occurred as a result of drilling and production rigs in the Gulf of Mexico.

Comment 2

Beginning on page V-2 , there is a detailed discussion on energy imports of both oil and gas that has been extracted from the Department of the Interior analysis entitled "Energy Alternatives and their Related Environmental Impacts."

Comment 3

This comment regarding imposing restrictions on the development of estuaries having breeding grounds for rare species is a matter that falls under the jurisdiction of Federal and State agencies that authorize and license the oil and gas drilling sites.

Comment 4

The comment that consideration be given aesthetic values in sensative areas is normally included in an environmental impact statement that is issued by DOI prior to leasing drilling sites in a specific area.

OFFICE OF THE GOVERNOR
DIVISION OF PLANNING COORDINATION

DOLPH BRISCOE
GOVERNOR

JAMES M. ROSE
DIRECTOR

July 10, 1975

Dr. Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs
Maritime Administration
U.S. Department of Commerce
Washington, D. C. 20230

Dear Dr. Galler:

The draft environmental impact statement (EIS), titled "Title XI - Vessels Engaged in Offshore Oil and Gas Drilling Operations", prepared by the Department of Commerce, has been reviewed by the Governor's Division of Planning Coordination and by interested State agencies as required by the National Environmental Policy Act of 1969.

The review participants generally agreed that the cited draft EIS adequately outlines the impacts of vessels engaged in offshore oil and gas drilling operations. They also recognized that the draft EIS provides an excellent description of the programs involved in the development of the outer continental shelf and in the Coastal Zone Management Program.

The Division of Planning Coordination believes that comprehensive planning is essential for the rational and environmentally sound development of the outer continental shelf. Due to the complexity of this effort, it is essential that the States participate in the planning process to provide for continued effective Federal-State coordination.

The comments of the review participants are enclosed to assist in your planning effort. If we can be of further assistance, please let us know.

Sincerely,

James M. Rose

JAMES M. ROSE
Director

JMR/sm
cc: The Honorable Bob Armstrong, General Land Office
Mr. Clayton T. Garrison, Texas Parks and Wildlife Department
Mr. Joe C. Moseley II, Texas Coastal Marine Council
Mr. Charles R. Barden, Texas Air Control Board

P. O. BOX 12428, CAPITOL STATION, AUSTIN, TEXAS 78711
Phone 512/475–2427 Offices Located in Sam Houston State Office Building

OFFICE OF THE GOVERNOR
DIVISION OF PLANNING COORDINATION

DOLPH BRISCOE
GOVERNOR

JAMES M. ROSE
DIRECTOR

RECEIVED
MAY 19 1975
NATURAL RESOURCES SECTION

May 15, 1975

TO: Mr. Joe B. Harris, Division of Planning Coordination/Natural Resources 05/27/75
Mr. Bill Duncan, Division of Planning Coordination/Energy Resources 06/06/75

SUBJECT: DRAFT ENVIRONMENTAL IMPACT STATEMENT: MARITIME ADMINISTRATION TITLE XI - VESSELS ENGAGED IN OFFSHORE OIL AND GAS DRILLING OPERATIONS

Enclosed for your review and comment is the draft environmental impact statement prepared by the Department of Commerce for the Maritime Administration Title XI - Vessels Engaged in Offshore Oil and Gas Drilling Operations. The Intergovernmental Coordination received a limited number of this draft environment impact statement, so it will be necessary for you to forward it to the next DPC Section listed by the date after your name. Energy Resources should return the draft to this section.

Please submit your comments to this section; for questions contact Albert D. Schutz at 6156.

Thank you for your assistance.

Sincerely,

Wayne N Brown

Wayne N. Brown, Chief
Intergovernmental Coordination

WNB/ws
Enclosure

P. O. BOX 12428, CAPITOL STATION, AUSTIN, TEXAS 78711
Phone 512/475–2427 Offices Located in Sam Houston State Office Building

TEXAS AIR CONTROL BOARD

PHONE 512/451-5711
8520 SHOAL CREEK BOULEVARD

CHARLES R. BARDEN, P. E.
EXECUTIVE DIRECTOR

AUSTIN, TEXAS – 78758

May 23, 1975

Mr. Wayne N. Brown, Chief
Intergovernmental Coordination
Office of the Governor
Division of Planning Coordination
P. O. Box 12428, Capitol Station
Austin, Texas 78711

Dear Mr. Brown:

Our agency has reviewed the Draft Environmental Impact Statement: Maritime Administration Title XI - Vessels Engaged in Offshore Oil and Gas Drilling Operations. We feel this document adequately assesses the impact of this project on the environment. We see no conflict with this project and our State Implementation Plan.

Thank you for the review opportunity. If we can be of further assistance, please contact me.

Sincerely yours,

Bill Stewart, P.E.
Director
Control and Prevention

COMMENTS

Natural Resource Section

DES Maritime Administration Title XI Vessels Engaged in Offshore Oil and Gas Drilling Operations

BACKGROUND. The Maritime Administration Title XI program is a vital part of the 1970 Merchant Marine program designed to rejuvenate the declining U. S. Flag Merchant Marine Fleet both for economic and national defense reasons. This program has as its central purpose the encouragement of construction and maintenance of a privately owned and operated Merchant Marine Fleet of modern design and balanced composition. The Federal government guarantees financial obligations and holds all mortgages and notes as security for these obligations. This Draft Environmental Statement deals with the impacts of the offshore gas and drilling and support vessel program (offshore program) and centers on modern drilling and support vessels for exploratory work in discovering petroleum sources located on the Outer Continental Shelf.

GENERAL REVIEW.

1. A general discussion of the role of states and other political subdivisions in resource management may be found on page IV-18. The Coastal Zone Management Act of 1972 is described. The federal consistency provision is mentioned and the need for all federal agencies to coordinate federal plans with approved state coastal zone management plans is explained.

2. Land use legislation pending in Congress and its possible impacts are briefly described.

3. This DES recognizes the need for effective Federal-State coordination because geologic boundaries for exploration and development activities do not correspond to political boundaries. Effective regulation of OCS production and related activities, therefore, requires concerted action at all levels of government.

4. Quite correctly, in a statement on page IV-19, it is indicated that each state's paramount interest is to protect fisheries, harbors, coastal wetlands, beaches, and other natural resources from the devastating longlasting damage inflicted by the extraction of a nonrenewable resource as well as to foster continued economic and social well-being.

5. The DES also indicates that under P. L. 92-583 any Coastal Zone Management Plan must provide "adequate consideration of the National Interest involved in the citing of facilities necessary to meet requirements which are other than local in nature." There are important limitations to the Coastal Zone Plan as a vehicle for joint OCS planning. The act creates a non-mandatory system, and its financial

incentives may be insufficient to accomplish its lofty aims. "The potentially conflicting interests are so complex as to render impossible fully satisfactory solutions to all issues. At a minimum, however, state Coastal Zone Plans can contribute to more rational decisions concerning OCS and Coastal Zone Uses by improving interaction between state and federal decision-makers prior to committing OCS and onshore resources to development."

6. The DES also includes an objective analysis of the impact which can result from conflicting state and regional regulations for environmental and safety conditions. Offshore drilling rigs, vessels, and other equipment are subjected to a variety of state and/or regional controls which alter their designated construction and restrict their operation within certain areas.

COMMENTS: In summary, this DES does an excellent job of describing the many programs dealing with OCS development and Coastal Zone Management. The report is very thorough and comprehensive. The environmental impacts stemming from public subsidization of the offshore drilling and support vessel program are of a general nature having to do with the potential for spills and other adverse impacts resulting from oil and gas drilling, trans-shipping, and pumping through pipelines within a marine environment. Because of this generality, there are no specific items dealing with particular Texas conditions and no recommendations for improvement are deemed necessary.

John M. Gosdin

John M. Gosdin — May 30, 1975

Jean Williams

Jean Williams — May 30, 1975

TO: Al Schutz
FROM: Bob Davis
SUBJECT: DEIS on Maritime Administration Title XI
DATE: May 29, 1975

We received a copy of the DEIS on May 28 from John Gosdin. I read the document and have but one comment. On page III-1 there is a table (Table IIIA-1) purporting to give reserve figures. The figures are actually resource estimates as the text above the table notes. However, the table states that the figures are reserves. The actual proved reserves reported by industry for the end of 1974 show that the U.S. has about 34 billion barrels. The table in question shows that the OCS has 201 billion barrels or about six times the U.S. total. The table title should read "resource estimate" instead of "reserves."

As our knowledge of phytoplankton and semisubmersible rigs is rather limited this is the extent of our comments.

OFFICE OF THE GOVERNOR
DIVISION OF PLANNING COORDINATION
STATE CLEARINGHOUSE
Ph. 512/475-6156

DOLPH BRISCOE
GOVERNOR

JAMES M. ROS
DIRECTOR

COMMENTS

The Texas Parks and Wildlife Department has reviewed the draft environmental statement, Vessels Endangered in Offshore Oil and Drilling Operations. We have forwarded the statement to the Texas Water Quality Board, as requested by your office.

We feel that information in the document is well presented and that the general impact on fish and wildlife from the offshore oil and gas activities presented can be ascertained from a review of the document.

Thank you for the opportunity to review this document.

Person Conducting Review (Signature) Robert L. Cooksey

Agency Texas Parks and Wildlife Department Date May 22, 1975

SAI No. ______ Applicant ______

TEXAS COASTAL AND MARINE COUNCIL

May 28, 1975

Mr. Wayne N. Brown, Chief
Intergovernmental Coordination
Office of the Governor
Division of Planning Coordination
PO Box 12428 Capitol Station
Austin, Texas 78711

Dear Mr. Brown:

I have briefly reviewed the document entitled DRAFT ENVIRONMENTAL IMPACT STATEMENT: MARITIME ADMINISTRATION TITLE XI - VESSELS ENGAGED IN OFF-SHORE OIL AND GAS DRILLING OPERATIONS, and the Texas Coastal and Marine Council has no objections or other constructive comments to make.

Sincerely,

Joe C. Moseley II

Joe C. Moseley II

MCM/maj

POST OFFICE BOX 13407 / AUSTIN, TEXAS 78711 / PHONE (512) 476-3561

State of Texas

The Office of the Governor distributed copies of the DEIS to various agencies of the government of Texas for their individual review and comments. The consensus of opinion was that the DEIS adequately described the project and only one comment was submitted for consideration in the preparation of the final statement.

The comment from the State of Texas relates to Table IIIA-1 on page III-1 of the DEIS concerning OCS oil and gas reserves. This table has been completely removed and Chapter III restructured in its entirety.

2000 West Loop South • Suite 2222 • Houston, Texas 77027
(713) 627-3030 • TWX 9108815063

Clay Chiles
president

June 19, 1975

Mr. Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs
Department of Commerce
Washington, D.C. 20230

Subject: Comments - Draft Environmental Impact Statement Prepared by The Department of Commerce for the Maritime Administration Title XI

Dear Mr. Galler:

First, I would like to express my appreciation for the opportunity of reviewing the draft environmental impact statement which was prepared by the Department of Commerce for the Maritime Administration Title XI - Vessels Engaged in Offshore Oil and Gas Drilling Operations. The impact statement presents an excellent background on the development of the offshore drilling industry and the environmental factors that are related to this portion of the industry.

Benefits of the Maritime Administration Title XI financing for offshore drilling vessels were only briefly covered in the draft environmental impact statement. Some of the benefits that we feel should be highlighted include:

1. The Maritime Administration Title XI financing was one of the major factors allowing U.S. offshore drilling companies to build offshore drilling vessels before foreign concerns entered this important market. As a result, many of the U.S. offshore drilling companies are in an advantageous competitive position in the world market.

A Subsidiary of The Western Company of North America

2. The Maritime Administration Title XI financing allowed several smaller U.S. companies to participate in the expansion of the offshore drilling industry which might not have been possible otherwise. This should provide a healthier competition in the offshore drilling industry and ultimately provide lower costs of petroleum products for the consumer.

3. The Maritime Administration Title XI financing has provided additional vessels for work in the United States Continental Shelf areas as the demand for these vessels expanded during the past few years. For example, the Western Company of North America has two vessels, the Western PACESETTER II and the Western PACESETTER III which were financed under the Title XI program and are now working offshore in the Gulf of Mexico.

We would like to particularly emphasize our concurrence with the third alternative to the MARAD program which is outlined on Pages V-4, 5 and 6 of the impact statement. The current generation of offshore drilling vessels is designed to meet stringent environmental requirements by the U.S. Coast Guard, the American Bureau of Shipping, the U.S. Geological Survey, and the Department of Defense as well as provisions of IMCO's 1973 Marine Pollution Convention. Therefore, we concur with the statement that it would be difficult for MARAD to attempt to devise environmental standards above and beyond those presently required.

Although private industry has not undertaken work on a centrally coordinated basis for the design of offshore equipment to prevent pollution as pointed out on Page V-6, the companies involved in the offshore drilling industry have through conferences and cooperation between drilling contractors, equipment vendors and operators developed the designs for many new sophisticated pieces of equipment and substantially improved existing equipment and systems to prevent pollution. Such equipment includes: blowout prevention equipment, riser and subsea control systems, well testing equipment, vessel sewage systems, drilling mud control systems, and well completion equipment and systems.

In summary, we feel that the U.S. Department of Commerce Maritime Administration has acted judiciously and equitably in requiring that the offshore drilling vessels built under the Title XI program meet the environmental standards set by other related U.S. governmental agencies which have developed sound environmental standards over many years. In addition, the MARAD Title XI program has been extremely beneficial for the U.S. offshore drilling industry and should be continued in the future under the current guidelines.

Sincerely yours,

Clay Chiles

Clay Chiles
President

BKV:dd

Western Oceanic Incorporated

Comments submitted by this company indicated the importance of the Title XI financing program to the offshore drilling industry; and, with the exception of expanding the program description (which has been done), no further response to the comments is believed necessary.

THE OFFSHORE COMPANY
P. O. BOX 2765 • HOUSTON, TEXAS 77001
713/622-5670 • Cable: OFFDRILL

June 5, 1975

Mr. Sidney R. Galler
Deputy Assistant Secretary
 for Environmental Affairs
United States Department of
 Commerce
Maritime Administration
Washington, D. C. 20230

Dear Mr. Galler,

Please find enclosed our comments to your proposed Environmental Impact Statement for MarAd's Title XI program - Vessels Engaged in Offshore Oil and Gas Drilling Operations.

If you have any questions relating to our comments or otherwise, we will be glad to assist you.

Sincerely,

THE OFFSHORE COMPANY

Harold F. Leyh
Harold F. Leyh
Staff Engineer

HFL/cs
Attachment

COMMENTS BY THE OFFSHORE COMPANY

TO ENVIRONMENTAL IMPACT STATEMENT

AS PROPOSED BY MARITIME ADMINISTRATION ON MAY 2, 1975

Page III-3 A few revisions should be made so that the layman obtains a proper conception of the role drilling mud plays. In the first paragraph, last two lines are suggested to be changed as follows:

"At the ocean bottom surface a pipe (riser) further carries the cuttings in suspension ......etc. Sporadically, depending on water depth, when soft formation is suddenly encountered it might be required to release the mud column in the riser, whole or in part, by opening a dump valve at the ocean floor".

Page III-8 Second Paragraph.

Change the word "often" to "occasionally" which is factual and consistent with the first sentence of the last paragraph on that same page.

Third Paragraph.

Change to read ".....offshore operations could discharge a variety of materials....etc."

Page III-9 Table III A-2.

With reference to mercury pollution by sacrificial anodes tests by Dow Chemical and Shell with Galvalun anodes have shown that the mercury discharge added only .08 parts per trillion to the water flowing through under the platform, against a natural average seawater mercury contents of 1200 parts per trillion. Hence, one can hardly state that

the biological impact is significant, even locally.

Page III-10 It is recommended to leave out any estimated figures on worldwide oil pollution, whether through natural seepage, pleasure boats or blowouts. Such figures necessarily are very rough estimates, moreover they do not belong in an Environmental Impact Statement, which is supposed to cover the impact of oil drilling on the environment within the United States' outer Continental Shelf and which should restrict itself to as many hard and relevant facts as possible.

Page III-11 & 12 The Table III A-3 lists 2 oil spills connected with drilling operations during the 1953-1972 period. According to the text on Page III-11, the Santa Barbara 1969 blowout accounts for the entire oil spill listed in the table. Hence, either the other event was not an oil spill or the estimated figure of 18,500-780,000 barrels for the Santa Barbara spill is incorrect. It is noted here that an "estimate" with such a range is hardly worth quoting in an official document.

It is not understood why a lot of statistical data on oil spills from tankers, platforms and pipelines is included where the Environmental Impact Statement is supposed to cover only the offshore drilling operation aspect. It is recommended that most of Chapter 2 thru 6 be eliminated and the remainder (if any) be written in such a way that it is comprehensible to the layman, and restricts itself to exploratory drilling and offshore supply vessels. It is pointed out here that exploratory drilling as done by the

drilling units intended to be the subject of this Environmental Impact Statement (see listing on Page I-8) is not done by platforms. The latter are fixed units used for production drilling. It is stressed here that due to the closely spaced multiple wells drilled from a production platform, a blowout in one causes an inherently greater risk for a large oil spill than exists when drilling one exploratory well.

The text on the bottom of Page III-11 and top of Page III-12 shows oil spill figures which total to 84,000 barrels as a minimum and 161,000 barrels as a maximum. However, Table III A-3 shows the same arithmetic as 84,000 to 135,400 barrels. One of the maximum figures must be wrong.

Page III-24 We object to the use of as yet completely unfounded statements such as: "Some scientists believe that over the life of a field these intentional releases may damage the environment as much as the large accidental oil spill." We request that this sentence be eliminated. The E.I.S. is not to serve as a summary of speculative statements.

Further on Page III-24 & -25, we object to stating mud discharge figures without stating a time period over which this discharge takes place. In pollution matters, the discharge rate is more important than quantity. The 110 tons of mud may represent a rate of 0.1 tons/hour but since barite has a specific gravity of 4.5 and the mud contains approximately 90% water, it amounts to slightly less than 2 cubic feet of

barite solids per hour. The realization of the 1,120 wells may take 10 to 15 years.

Page III-29 In the second paragraph, the sentence, "Furthermore, the oil released from sediments may contain pesticides...etc. is objected to as being too speculative and not relevant to the subject of the report.

Page III-31 The second sentence of the second paragraph, "Energy imparted by winds....etc." is not clear. It could be eliminated.

Page V-3 thru 6 With reference to Chapter B, we do not see the importance of it in an environmental impact statement, the requirement of which is based on the presumption that the MarAd program continues as is. Besides, the economic logic at various points in the text is questionable. With respect to Page V-6, we certainly do not see a need for the Federal Government to enter into research activities concerning design of equipment.

Page VI-1 Chapter VI, Para. A, does not belong in the E.I.S. for Mobile Offshore Drilling Units and Support Vessels. The pollution impact by steel mills and other industries necessary for construction of drilling units and vessels is supposed to be dealt with in separate E.I.S.'s relating to those industries. If one would allow Chapter VI to be included, then one would also have to look at the possible extra machinery and equipment needed by the steel mills or other industries and, in turn, would have to be manufactured, thereby forming a pollution risk, etc., etc. One may assume

that any material necessary for the construction of Mobile Offshore Drilling Units and Support Vessels can be manufactured within the standards set by E.P.A. Don't blame the Offshore Drilling activity for steel mill pollution!

Appendix

Page A-23 thru -30 On Page A-23 thru A-26 of the Appendix, an interesting expose, by itself, is given on the very young field of chemical communication. It is felt that this does not belong in the E.I.S, since it is dealing with a field which is in its infancy and no positive and conclusive figures can be presented showing the relationship between an oil spill rate and the interruption of, or impedance with, chemosensitivity. The E.I.S. should not allow itself to penetrate itself into all the various intricate mechanisms by which marine life can be detrimentally affected but should keep itself to measurable and conclusive total results. In other words, "how much". Let the scientists figure out "why".

The same comment, to some extent, holds true for Page A-27 thru -30. It is a fascinating scientific resume on toxidity levels but it does not serve the purpose of the E.I.S. and does not belong in it as such.

General One very interesting research activity by Gulf Universities Research Consortium is overlooked. It is described in 1975 O.T.C. Paper Nr.2384 and states that no harmful, sometimes

beneficial, effects in the ocean were measured as a result of offshore drilling.

Other beneficial effects, which do exist, are not addressed at all in the E.I.S. For example, improved and more timely weather data collection, better search and rescue systems due to more frequent sailing of supply boats and fly over of helicopters and, in general, a vast expansion and acceleration of research activity and use of computer techniques in the fields of ship dynamics, stress mechanics, welding, corrosion, and fatigue, just to name a few, which benefit other related industries and designs, thereby reducing their environmental impact risk.

One important trend should be mentioned which is that the continued search for offshore oil brings the drilling unit further and further from shore and into deeper water (a 5000 ft. depth design is presently under consideration). This means that any accidental oil pollution requires much more time to reach shore allowing more time for clean up preparation while drifting to shore but also increasing the chance for breakdown as described in the E.I.S. (evaporation, photo chemical, biochemical, etc.)

The increased water depth will greatly reduce the pollution danger to ocean bottom life firstly because of the longer sinking time and consequently greater dillution; secondly, because bottom life reduces as depth increases.

In conclusion, we can state that, taking our above comments into consideration, the E.I.S. is correct in that it cannot produce hard evidence of long range detrimental environmental impacts.

The Offshore Company

Disposition of comments submitted by the Offshore Company are identified as they relate to the page number of the DEIS shown on the attachment to their letter of June 5, 1975.

Page III-3 - Comment is reflected on page III-2.

Page III-8 - Comment is reflected in the revision of Chapter III on page III-71.

Page III-9 - Table IIIA-2 has been removed from the Statement.

Page III-10 - A more accurate estimate of worldwide oil pollution has been included in the revision of Chapter III on page III-12. By including data on worldwide oil pollution from all sources, the oil pollution from offshore oil and gas operations can be viewed in perspective.

Pages III-11 and 12 - Comments referring to oil spill volumes have been addressed by changes on pages III-13.

The EIS addresses the environmental impact of offshore oil and gas field development, production, transportation, and storage operations because these activities are direct results of exploratory drilling.

Page III-24 - Comment is reflected in the revision to Chapter III on page III-12.

Page III-24 and 25 - The comment concerning mud discharge figures has been noted, and changes to the text have been made on page III-73.

Page III-29 - The statement: "Furthermore, the oil released from sediments may contain pesticides ... etc." has been retained for purposes of presenting a complete analysis.

Page III-31 - Comment is noted on page III-52.

AMERICAN PETROLEUM INSTITUTE
1801 K STREET, NORTHWEST
WASHINGTON, D.C. 20006

WILSON M. LAIRD, *Director*
Department of
Exploration Affairs

(202) 833-5722

May 14, 1975

Mr. Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs
Maritime Administration
U.S. Department of Commerce
Washington, D.C. 20230

Dear Sid:

As requested in your May 7 letter, enclosed are comments on the draft environmental impact statement prepared by the Maritime Administration on "Vessels Engaged in Offshore Oil and Gas Drilling Operations."

Although restricted primarily to Chapter II, "General Description of the Marine Environment," and Chapter III, "Environmental Impact of OCS Drilling, Servicing and Support Operations," I hope my somewhat hurried review will prove helpful.

Enclosed is a copy of the Spring 1975 issue of FLUOR Magazine which is devoted to The Marine Environment. Your attention is directed particularly to the article beginning on page 11 entitled, "The Offshore Ecology Investigation."

Sincerely,

Wilson

WML:amj
cc: Paul Wollstadt
Enclosures - 1) FLUOR Magazine
2) Fishing's Great Along the Louisiana Coast!
3) The Gulf is Rigged for Fishing
4) New Estimates of Nation's Oil and Gas Resources

Comments on
Draft Environmental Impact Statement
Maritime Administration Title XI -
Vessels Engaged in Offshore
Oil and Gas Drilling Operations

p. II-10

The section entitled "Geological Framework of the Continental Shelf" is naive beyond belief. In fact, this apparently has been written with the idea that the reader is so poorly informed that he can't understand even the most elementary geological facts. It is totally unacceptable and should be entirely rewritten. The definitions of the various physiographic forms found in the sea bottom should be made to conform with the definitions in the "Glossary of Geology" published by the American Geological Institute.

Chapter III, p. III-1

The resource figures used herein will be outdated when the new USGS estimates are released in June 1975.

p. III-3, A. Primary Source

Geophysical investigations do not determine if oil and gas formations are present. This type of survey simply gives information as to the thickness of potential oil-bearing formations and possibly something about the geological structural configuration of the area under study.

In no case are the drilling muds and cuttings discharged directly into the ocean because the materials are not returned

to the surface due to the depth of the water. It would be impossible to drill a hole in this fashion. The drilling mud and the cuttings are returned to the floor of the rig by means of a riser pipe which in turn is used to return the mud to the drilling face where the bit is cutting the formation. The cuttings and the mud, if no longer usable, may be disposed of overboard provided any oil which might be contained therein is removed.

p. III-8

There is no positive evidence that the disposal of the drilling mud and cuttings causes any damage to the ocean. In fact, the drill cuttings may provide a hard substrate upon which bottom dwelling organisms may live even where such were not able to survive before. In addition, the amount of salt water released into the ocean is so small that it is diluted beyond recognition a very short distance from the point of discharge.

p. III-10

I question the figures which are quoted without reference which are attributed to the Woods Hole Oceanographic Institute and the Coast Guard. I refer you to the accompanying table 1-5 taken from the National Academy of Sciences report entitled "Petroleum in the Marine Environment" published in 1975. You will note that the NAS report estimates that the amount

TABLE 1-5 Budget of Petroleum Hydrocarbons Introduced into the Oceans

Source	Input Rate (mta)[a]		Reference
	Best Estimate	Probable Range	
Natural seeps	0.6	0.2–1.0	Wilson *et al.* (1973)
Offshore production	0.08	0.08–0.15	Wilson *et al.* (1973)
Transportation			
LOT tankers	0.31	0.15–0.4	Results of workshop
Non-LOT tankers	0.77	0.65–1.0	panel deliberations
Dry docking	0.25	0.2–0.3	
Terminal operations	0.003	0.0015–0.005	
Bilges bunkering	0.5	0.4–0.7	
Tanker accidents	0.2	0.12–0.25	
Nontanker accidents	0.1	0.02–0.15	
Coastal refineries	0.2	0.2–0.3	Brummage (1973a)
Atmosphere	0.6	0.4–0.8	Feuerstein (1973)
Coastal municipal wastes	0.3	–	Storrs (1973)
Coastal, Nonrefining, industrial wastes	0.3	–	Storrs (1973)
Urban runoff	0.3	0.1–0.5	Storrs (1973), Hallhagen (1973)
River runoff	1.6	–	Storrs (1973), Hallhagen (1973)
TOTAL	6.113		

[a]mta, million metric tons.

barrels per barrel of oil produced. This loss factor should be representative of other U.S. offshore operations. In this case, the total loss due to minor spills from U.S. offshore operations is 1,500 barrels per year (based on 1971 U.S. offshore production of 618 million barrels, McCaslin, 1972).

In some other parts of the world, quantitative reports suggest that losses due to minor spills may average 10 times greater than those that occur in U.S. waters. Accordingly, the loss due to minor offshore spills outside the United States is estimated to be 62,000 barrels per year (based on 1971 foreign offshore production of 2,580 million barrels per year, McCaslin, 1972). Thus, the total worldwide loss of oil through minor spills during normal offshore operations is estimated at 63,500 barrels or approximately 0.01 mta.

TABLE 1-6 Comparison of Estimates for Petroleum Hydrocarbons Annually Entering the Ocean, circa 1969-1971

Source	Authority (Millions of Tons per Annum)		
	MIT SCEP Report (1970)	USCG Impact Statement (1973)	NAS Workshop (1973)
Marine transportation	1.13	1.72	2.133
Offshore oil production	0.20	0.12	0.08
Coastal oil refineries	0.30	–	0.2
Industrial waste	–	1.98	0.3
Municipal waste	0.45	–	0.3
Urban runoff	–	–	0.3
River runoff[a]	–	–	1.6
SUBTOTAL	2.08	3.82	4.913
Natural seeps	?	?	0.6
Atmospheric rainout	9.0[b]	?	0.6
TOTAL	11.08	?	6.113

[a]PHC input from recreational boating assumed to be incorporated in the river runoff value.
[b]Based upon assumed 10 percent return from the atmosphere.

The estimate of oil loss via field brine discharges is obtained in a similar manner. Brines that are produced along with the oil and gas are usually discharged into the sea after passing through an oil-water separator. These brines still contain small amounts of oil. Under present federal regulations, this amount of oil cannot exceed 50 parts per million (ppm) of produced brine. According to the U.S. Department of the Interior (1972b), 7.3 barrels of waste oil per day were discharged into the Gulf of Mexico, along with 180,000 barrels per day of brine, resulting in an average oil content of 41 ppm. This occurred during the daily production in the Gulf of Mexico of 1.2 million barrels of oil during 1971. It is equivalent to a loss of 6.0 barrels per million barrels of oil produced.

Depending on the separator used, the oil content of treated brines in other parts of the world may be up to four times higher than the level allowed in the Gulf of Mexico at present. While worldwide data on volumes of produced brines are not available, it is not likely that economic self-interest will allow higher brine percentages from producing wells in other parts of the

of oil going into the ocean on a worldwide basis from oil drilling operations is about 1%.

p. III-24

In discussing the matter of chronic spills, the statement is made, "Some scientists believe that over the life of a field these intentional releases may damage the environment as much as the large accidental oil spill." In the first place, this statement has not been proven and, secondly, it implies that the releases are always intentional.

p. III-36

It should be pointed out that, in listing what effects oil may have on an organism, there is the possibility that the oil may have no lasting effect at all.

p. III-37

The statement, "The incorporation of hydrocarbons, including carcinogens, is of particular concern because they accumulate in marine organisms and can be transferred to other organisms through the food web", is not necessarily substantiated in fact. For example the NAS report says: (p.37)

> "Measuring the effects of oil on marine life is difficult. Each experimental study must include an adequate number of controls whereby single variables are evaluated through interdisciplinary approaches so that the effects of different biological parameters can be resolved. Many earlier studies of the effects of oil cannot be adequately evaluated because (1) the experimental work was not properly designed (for example lack of adequate

> replication) and (2) the oil concentrations and other variables that affect marine life were inadequately monitored."

p. III-39

I find Table IIIA-8 difficult to rationalize, particularly when it comes to fish. Fish will swim away from any area in which they find life unbearable for any reason. The only exception would be where the spill occurred in some enclosed or semi-enclosed basin where the nektonic life was unable to escape. In addition, this table does not indicate what concentrations would be lethal. Obviously, practically any substance unnatural to the organism would be lethal if the organism were exposed to it long enough and in great enough quantity. That all oil is not lethal to fish and some other marine life, one has only to make observations in the Santa Barbara Channel where the marine life has been exposed to natural seeps of considerable size over tens of thousands of years. For larva, the conditions would obviously be different as such might not have the mobility of mature forms.

p. III-42

As far as birds are concerned, it is true that an oil spill is a disastrous occurrence in local areas. Bird mortality is high under natural conditions and under the pressure of hunting. I doubt if as many birds die due to exposure to oil spills as are killed illegally each year,

especially in the case of migratory birds which fly to countries having less rigorous hunting laws than the United States. In any event, it is highly unlikely that all the birds on a given flyway would be entrapped in an oil spill, so recovery would not depend only on those which were unfortunate enough to be caught in any given oil spill.

p. III-46

The sewage which is produced by human occupants of the rigs and platforms is regulated by OCS order number 8 of the U.S. Geological Survey. A copy of that portion of the order which covers this matter is appended herewith. It is worth noting, that this treatment is far better than the plants which are daily discharging contaminated effluent into the Potomac River here in the Washington area.

p. III-7-, 72

In the discussion of commercial fishing, it is interesting to note that no mention was made of the fishing industry in Louisiana. California is listed as the second most important fishing state, but no mention is made of which state is first. Incidently, there is no Table III-B-1 in the copy which I read. It is also notable by its absence that no mention is made of the sport fishing associated with the offshore rigs in the Louisiana area where excellent fishing is well documented.

(b) All electrical generators, motors, and lighting systems shall be installed, protected, and maintained in accordance with the most current edition of the National Electric Code and API RF 500A and B, as appropriate.

(c) Marine-armored cable or metal-clad cable may be substituted for wire in conduit in any area.

(9) Sewage disposal systems shall be installed and used in all cases where sewage is discharged into the Gulf of Mexico. Sewage is defined as human body wastes and the wastes from toilets and other receptacles intended to receive or retain body wastes. Following sewage treatment, the effluent shall contain 50 ppm or less of biochemical oxygen demand (BOD), 150 ppm or less of suspended solids, and shall have a minimum chlorine residual of 1.0 mg/liter after a minimum retention time of fifteen minutes.

B. The requirements of subparagraphs 2. A (3), (4), (8), and (9) shall apply to all mobile drilling structures used to conduct drilling or workover operations on Federal leases in the Gulf of Mexico.

Robert F. Evans

Robert F. Evans
Supervisor

Approved: October 30, 1970

Russell G. Wayland

Russell G. Wayland
Chief, Conservation Division

p. A-18

If there is a direct correlation between light oil concentration and cancer it should be definitely noted and the source of the information indicated.

May 14, 1975

Submitted to: Sidney R. Galler

DEPARTMENT of the INTERIOR

news release

GEOLOGICAL SURVEY

Forrester (703) 860-7444

FROM
WILSON M. LAIRD
DIVISION OF EXPLORATION
AFFAIRS

For Release on Receipt (May 7, 1975)

NEW ESTIMATES OF NATION'S OIL AND GAS RESOURCES

New estimates of the Nation's crude oil and natural gas liquids and natural gas have been prepared by a team of geologists of the U. S. Geological Survey, Department of the Interior.

The estimates have been compiled by a new Resource Appraisals Group under the leadership of Harry Thomsen, a petroleum geologist at the Survey's Denver, Colo., office. Only summary figures of estimates are available now.

A full, more detailed report, now in final preparation, will be delivered by the end of May to the Federal Energy Administration, and will be made public at the same time.

Although considerably lower than the Survey's estimates of March 1974, the new estimates indicate that the target for exploration is substantial. For example, undiscovered recoverable resources of oil are estimated to be in the range of 50 to 130 billion barrels and 320 to 655 trillion cubic feet of natural gas. In addition, some 30 billion barrels of oil and 180 trillion cubic feet of gas are estimated to be recoverable from unexplored parts of known fields.

In discussing the new appraisals, Dr. V. E. McKelvey, USGS Director, said that they are derived primarily from geologic evaluations, and, as in any dynamic process, are subject to considerable change with time and with application of new geologic data and techniques. Moreover, the new estimates have not assumed high prices because of the difficulty of assessing their impact to date, but the estimates would be increased by assumptions of continued higher prices and exploration on the OCS beyond 200 meters.

(more)

McKelvey said that the Thomsen group started its special mission in February 1974 with guidelines to "think in other categories," and to develop a set of appraisals that would make the wide range of estimates more useful for planning purposes.

Departing from previous approaches to oil and gas estimates, the Thomsen group -- involving more than 70 regional specialists -- analyzed more than 100 possible petroleum provinces individually, and combined them into 15 regions comprising the onshore and offshore conterminous lower 48 States and Alaska. Offshore estimates were made for continental shelf areas out to water depths of 200 meters (600 feet). New methods and techniques for resource appraisals were adopted, particularly geologic evaluation on a province-by-province basis. Additionally, large quantities of new geologic and geophysical data, hitherto not available to the USGS, were obtained and used.

"Perhaps the most important departure from previous approaches," McKelvey said, "was that the group applied probability limits for the estimates."

"By applying probabilities to these appraisals," McKelvey said, "we hope to establish, in a numerical sense, how much confidence can be placed in the various oil and gas estimates that now exist."

The USGS Director said that, "the problem is somewhat analogous to that of the insurance actuarian or statistician who, for example, might be asked how long a person can expect to live, and how much his insurance rates should therefore be. The statistician might be 95 percent sure that the person will live another year, but only 5 percent sure that he will live another 40 years."

"Similarly," McKelvey said, "the Thomsen group has tried to determine how much petroleum they can be 95 percent sure is available, and on the long-shot end of the scale, how much petroleum they are only 5 percent sure exists."

"Bearing this in mind," McKelvey said, "it is obvious that at the 95 percent confidence level, the estimated resource is small, but the chances are 19 in 20 that such amounts of petroleum do exist. On the other end, the 5 percent confidence end of the scale, the estimates are much larger, but the chances are only 1 in 20 that they are correct."

"The net effect of tightening previous estimates to fit the 95 and 5 percent confidence levels is to reduce the range of all estimates," McKelvey said.

(more)

"In considering such estimates," McKelvey emphasized, "it is most important to differentiate the categories being appraised, which fall under two general headings -- reserves and resources. Distinguishing between them gives a very rough count of 'birds in hand' and an estimate of 'birds in the bush.' Reserves are identified deposits known to be recoverable with current technology under present economic conditions, and can be estimated with a high degree of confidence. Resources, on the other hand, carry a high degree of uncertainty although some understanding of their potential is critical for the future. They include materials that may have been identified, but cannot now be extracted because of economic or technologic factors, as well as economic or subeconomic materials that are yet to be discovered."

"We are using probabilities in the case of resources," McKelvey said, "because in this broad category, we are trying to decipher the unknown, and this is particularly true of frontier areas in which not a single exploratory well has been drilled, and there is no assurance that petroleum in commercial quantities exists at all."

"The effect of changing economic and technologic conditions could appreciably affect the estimates," McKelvey said. "Thus, there are no 'true' or 'false' or 'right' or 'wrong' estimates for all time. They can, at best, be the very roughest guidelines and are subject to considerable change over time. For example, at the present time, in listing both reserves and resources, the Thomsen group assumed the usual 32 percent recovery factor; that is, that on the average, only 32 percent of the oil actually in the ground is recovered with sufficient economic incentive. The application of advanced secondary or tertiary oil recovery techniques, might, in the reasonably near future, boost the rate to 40 percent. It is not inconceivable that recoveries of 50 or even 60 percent may be achieved eventually. In addition, improvement of drilling technology and exploration science and technology might also increase the estimates. It is possible that the present meager data on frontier areas is misleading and has caused an underestimate of their potential. Finally, the petroleum resources of the Nation's continental shelves from 200-2,500 meters (600 feet to 7,500 feet) has not been estimated due to lack of data and this could materially alter the estimates."

While the new estimates are much lower than those released a year ago, they are higher than those of another U. S. Geological Survey scientist, Dr. M. King Hubbert, and are in the same range as those of the National Research Council of the National Academy of Sciences, and of those of the National Petroleum Council, which were used to develop Project Independence Blueprint estimates of possible future production.

(more)

The new use of the probabilistic approach in resource estimation allows a better comparison of previous differing estimates. For example, viewed in the context of the Thomsen group estimate, the 1974 Hubbert estimate of 55 billion barrels yet to be produced beyond proved reserves, which is lower than the Thomsen group estimate of 85 billion barrels for equivalent categories at the 95 percent probability level, would have a higher than 95 percent probability. Even though somewhat broader in its assumptions, the previous low estimate released by the Survey in 1974 of 200 billion barrels would have a much smaller probability than 5 percent judged by the probabilities established by the Thomsen group.

"These and the other higher and lower estimates all carry the same message on several important policy questions," McKelvey emphasized. "All indicate that substantial amounts of fluid hydrocarbons remain to be discovered if exploration is encouraged. All indicate that one of the largest targets for future production is the oil presently remaining in place that might be available if recovery technology is advanced. All emphasize the importance of frontier areas, and all show that it is necessary soon to develop other sources of energy as the mainstay of our future energy supply."

# # # # #

(Note to Editors: The new estimates are summarized in the attached table.)

U. S. PETROLEUM AND NATURAL GAS RESOURCES
(Onshore and offshore to water depth of 200 meters)

	CUMULATIVE PRODUCTION TO 12/31/73	RESERVES			RESOURCES
		MEASURED 2/ 12/31/74	INDICATED 3/ 12/31/74	INFERRED 4/	UNDISCOVERED 5/ RECOVERABLE 95% - 5%
Crude oil (billions of barrels) 1/	103.76	34.25	4.64	30	50 - 127
Natural gas liquids (billions of barrels)	14.97	6.35	---	6 6/	11 - 22 6/
Natural gas (trillions of cubic feet)	456.12	237.1	---	180	322 - 655

1/ Past production and estimates of reserves and resources reflect measured or estimated resources of about 32% of the oil in place. Some portion of the remaining oil in place is recoverable through enhanced recovery techniques.

2/ Explored deposits, recoverable under present economic conditions. Estimates are the "proved reserves" of the American Petroleum Institute and American Gas Association.

3/ Explored deposits, recoverable if known fluid injection technology is applied. Estimate is from the American Petroleum Institute.

4/ Recoverable oil in known fields not yet explored by drilling.

5/ That portion of the resources base judged to be discoverable and recoverable within the limits of 95% (19 in 20 chance) and 5% (1 in 20 chance) probability. At greater extremes of probability limits the range of values would increase.

6/ Estimates are derived from natural gas estimates by applying national NGL/gas ratios.

U. S. Department of the Interior
Geological Survey
May 1975

American Petroleum Institute

Disposition of comments submitted by the American Petroleum Institute are identified as they relate to the page number of the DEIS shown on the attachment to their letter of May 14, 1975.

Page II-10 - The Statement is written for the intelligent layman; a previous understanding of the marine environment is not presumed. Chapter II has been edited, however, to include a discussion of natural phenomena.

Page III-1 - The resources figures of Table IIIA-1 have been removed from the Statement.

Page III-3 - The Statement has been revised to indicate that a geophysical survey is used to locate geological formations which may potentially contain oil and gas.

The Statement concerning "the discharge of drilling mud and cuttings into the ocean" has been removed. Chapter III has been thoroughly revised and includes a detailed discussion of the disposal of drill cuttings and drilling muds.

Page III-8 - As noted previously, the revision of Chapter III includes a more thorough discussion of the disposal of drill cuttings and drilling muds.

Page III-10 - Comment is reflected in the revision to Chapter III on page III-13.

Page III-24 - Comment is reflected in the revision to Chapter III on page III-12.

Page III-36 - Chapter III has been revised to provide a more thorough discussion of the environmental effects of various discharges, especially of oil discharges.

Page III-37 - The quoted statement from the NAS report has been included in the Statement on page III-49.

Page III-39 - The text of Section III-E notes the mobility of fish and their tendency to avoid areas which are sensed as noxious or locally adverse.

Page III-42 - Comment regarding "entire breeding populations" and "all the birds on a given flyway" is reflected by a minor change in the revision to Chapter III on page III-63.

Page III-46 - Comment is reflected in the revision to Chapter III on page III-21.

Page III-7-72 - The revision to Chapter III includes a more thorough discussion of fishing and the effects of offshore oil and gas operations upon fishing.

K. W. WALDORF
President

Zapata Marine Service, Inc.

June 12, 1975

Dr. Sidney R. Galler
Deputy Assistant Secretary for
Environmental Affairs
Department of Commerce
Washington, D.C. 20230

Dear Dr. Galler:

With reference to the draft of the Environmental Impact Statement Maritime Administration Title XI vessels engaged in offshore oil and gas drilling operations, we have reviewed that portion of Chapter I which refers to offshore service vessels. Aside from obvious spelling and typographical errors, the below listed items are submitted as suggested changes to the draft.

Chapter I

Page 1-60, line 16 - change HP range to 3000 - 8000 HP
line 18 - change speed range to 12 - 16 knots

Page 1-62, line 3 - change fuel capacity to 90,000 - 130,000 gallons
line 4 - change bulk capacity to 2000 - 6000 cubic feet
line 8 - change cost estimate to 2-1/2 - 5 million dollars

Yours very truly,

KWWaldorf
K. W. Waldorf
President

/nrd

1601 HOUSTON CLUB BUILDING • HOUSTON, TEXAS 77002

Zapata Marine Service, Inc.

Comments relative to horsepower, speed and quantities have been incorporated and the figures revised accordingly.

H. E. DENZLER
101 NORLAND AVE.
NEW ORLEANS, LA. 70114

JULY 3, 1975

THE HONORABLE SIDNEY R. GALLER
DEPUTY ASSISTANT SECRETARY
DEPARTMENT OF COMMERCE
MARITIME ADMINISTRATION
WASHINGTON D. C. 20230

DEAR MR. SECRETARY:

YOUR INVITATION TO REVIEW AND COMMENT UPON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT OF THE MARITIME ADMINISTRATION TITLE XI - VESSELS ENGAGED IN OFFSHORE OIL AND GAS DRILLING OPERATIONS IS VERY MUCH APPRECIATED. ALSO APPRECIATED IS THE TIME EXTENSION GRANTED BY CAPTAIN STEINMAN, UNTIL JULY 15, FOR THE SUBMISSION OF THESE COMMENTS.

THE IMPACT STATEMENT IS VERY WELL DONE AND IT PRESENTS AN EXCELLENT REVIEW OF THE DEVELOPMENT OF THE OFFSHORE DRILLING INDUSTRY.

INASMUCH AS THE MARITIME ADMINISTRATION HAS ALREADY EMBARKED ON THE TITLE XI PROGRAM IT IS SUGGESTED THAT IT MIGHT BE PROPER, AND BENEFICIAL, TO INCLUDE SOME POSITIVE STATEMENTS INDICATING THE REASONS WHY MARAD IS WILLING TO CONTINUE AND IF NECESSARY EXPAND THIS PROGRAM. SOME REASONS MIGHT BE; TO ENCOURAGE U.S. CONSTRUCTION VERSUS FOREIGN; TO ENABLE SMALLER COMPANIES TO PARTICIPATE IN THE ACTIVITY; AND TO ASSIST IN FINANCING SUFFICIENT NUMBERS OF UNITS AND VESSELS FOR ORDERLY AND TIMELY DEVELOPMENT.

IT MIGHT ALSO BE OBSERVED THAT THE U.S. ENERGY SUPPLY IS ALREADY CONSIDERABLY LESS THAN DEMANDS BY SOME 35 - 50% AND THIS HAS A DECIDEDLY ADVERSE EFFECT ON THE U.S. BALANCE OF PAYMENTS POSITION.

ONE ITEM WHICH IS PARTICULARLY DISTURBING IS THE USE AND CITATION OF ITEMS TAKEN FROM THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY PAPER ON THE "ANALYSIS OF OIL SPILL STATISTICS", BECAUSE FRANKLY, THEY ARE CONFUSING AND INACCURATE IN RELATION TO THE AIMS AND PURPOSES OF YOUR IMPACT STATEMENT.

FOR INSTANCE, IF WE USE THE DEFINITIONS CITED ON THE BOTTOM OF PAGE III-16 WE FIND THAT THE ENTIRE WORLD HAS ONLY <u>ONE</u> "LARGE FIND", AT SAFANIYAH IN SAUDI ARABIA, AND IT CANNOT REALLY QUALIFY AS AN OFFSHORE FIELD SINCE A CONSIDERABLE PORTION OF IT IS ONSHORE; THE ENTIRE WORLD HAS ONLY TEN "MEDIUM FINDS", WITH ESTIMATED RESERVES OF OVER TWO BILLION BARRELS, PRINCIPALLY IN THE ARABIAN GULF, THE NORTH SEA AND IN VENEZUELA, BUT AS YET NONE PROVEN IN UNITED STATES WATERS; WORLDWIDE THERE ARE ONLY FORTY "SMALL FINDS" WITH ESTIMATED RESERVES OF FIVE HUNDRED MILLION BARRELS, WITH THE MAJORITY AGAIN BEING IN THE ARABIAN GULF AND THE NORTH SEA, AND WITH NONE IN UNITED STATES WATERS; EXCEPT POSSIBLY FOR WILMINGTON CALIFORNIA WHICH IS PARTIALLY ONSHORE.

THESE FIGURES, FROM THE OIL AND GAS JOURNAL, INDICATE THE EXTREME UNLIKELYHOOD OF SUCH MONSTEROUS "FINDS" EVER BEING DISCOVERED IN WATERS UNDER OUR

JURISDICTION. SINCE NO SUCH "FINDS HAVE BEEN DISCOVERED IN DRILLING THE BEST PROSPECTS OVER THE PAST TWENTY FIVE YEARS THE PROBABILITIES OF DISCOVERING SUCH IN THE FUTURE ARE PRACTICALLY NEGLIGIBLE.

CONSIDERING THESE FACTS ONE MUST WONDER ABOUT THE VALIDITY OF THE ASSUMPTIONS MADE IN SECTION 4 OF CHAPTER III SINCE NONE OF THEM CAN BE BASED ON FACTS RELATED TO OFFSHORE OPERATIONS IN WATERS UNDER THE JURISDICTION OF THE UNITED STATES, AND ONLY DUBIOUSLY TO WORLDWIDE WATERS.

AN EXAMINATION OF TABLES IIIA-5 AND IIIA-6 REVEALS A DECIDED VARIANCE BETWEEN THE QUANTITIES ATTRIBUTED TO PLATFORMS AND PIPELINES IN THE TWO TABLES. WHICH IS TO BE BELIEVED? ANOTHER QUESTION IS THE RELATION BETWEEN TERMINALS AND OFFSHORE OPERATIONS? IT IS SURELY OBVIOUS FROM THE QUANTITIES SHOWN THAT ALL THESE SPILLS CANNOT BE CONNECTED WITH OFFSHORE OPERATIONS.

IN THE PIPELINE PORTION OF THE TABLE IIIA-6 QUANTITIES APPEAR WHICH HAVE NO RELATION TO U.S. OFFSHORE DRILLING OR PRODUCING OPERATIONS; SPECIFICALLY THOSE IN THE PERSIAN GULF AND COASTAL CHANNELS ALONG THE GULF COAST. THESE ARE NOT TRULY RELEVANT TO THE PURPOSE OF THIS IMPACT STATEMENT.

AS FOR SECTION 5. TANKERS, THE SAME COMMENTS APPLY AS HAVE BEEN PREVIOUSLY EXPRESSED. HERE WE APPARENTLY HAVE AN ATTEMPT TO APPLY STATISTICS DERIVED FROM WORLDWIDE TANKER OPERATIONS TO AN ENTIRELY DIFFERENT OPERATION. THE USE OF TANKERS IN OFFSHORE DRILLING AND PRODUCING OPERATIONS COULD AT BEST BE ONLY A MINUTE PORTION OF PETROLEUM MOVEMENT BY TANKERS. IN FACT TWO MODERN TANKERS WILL CARRY MORE THAN SOME OF OUR MAJOR OFFSHORE FIELDS WILL PRODUCE IN AN ENTIRE YEAR! (ITEM 4 ON PAGE III-57, OR AT LEAST A REFERENCE TO IT, COULD INSERTED IN THIS SECTION 5 FOR CLARITY).

FINALLY M.I.T. TABLES IIIA-4 AND IIIA-7 COULD BE ELIMINATED BECAUSE OF THEIR MEANINGLESSNESS TO U.S. OPERATIONS.

PLEASE BE ASSURED THAT THESE COMMENTS ARE NOT INTENDED TO BE CRITICAL OF YOUR IMPACT STATEMENT WHICH IS VERY WELL DONE. THEY ARE SUBMITTED IN THE INTEREST OF PROVIDING INFORMATION WHICH YOU MAY WISH TO USE IN COMPILING THE FINAL STATEMENT.

SINCERELY,

H. E. DENZLER, JR.
OFFSHORE CONSULTANT

H. E. Denzler, Jr., Offshore Consultant

Mr. Denzler submitted comments on the DEIS in response to an invitation to review and comment sent to the International Association of Drilling Contractors. Beginning with the third paragraph of Mr. Denzler's letter the comments are responded to as follows:

Page 1, para. 3 - Chapter I has been revised to provide a better understanding of the Title XI program and also reflects the beneficial aspects to U.S. companies versus foreign competition.

Page 1, para. 4 - The comment relative to energy supply and demand is acknowledged however, due to wide fluctuations, it was considered prudent not to include this comment.

Pages 1 and 2, para's. 5, 6, 7 and 8 - The comments contained in these paragraphs take exception to data taken from the Massachusetts Institute of Technology Paper "Analysis of Oil Spill Statistics." While the comments may be valid the EIS must rely on published data.

Page 2, para's. 9 and 10 - Although Chapter III has been rewritten the tables identified as IIIA-5 and IIIA-6 in the DEIS have been kept for the same reasons stated above.

Page 2, para. 11 and 12 - These comments also take exception to the published MIT data therefore the same response applies to these two paragraphs.

CENTER
FOR
LAW
AND
SOCIAL
POLICY

1751 N STREET, N.W. WASHINGTON, D.C. 20036 202 872-0670

20 June 1975

COPY

Dr. Sidney R. Galler
Deputy Assistant Secretary for
Environmental Affairs
United States Department of Commerce
Washington, D.C. 20230

Maritime Administration Draft Environmental
Impact Statement on Title XI Financing Program
for Construction of Offshore Drilling Vessels

Dear Dr. Galler:

We are writing in response to the solicitation of views by the Federal Maritime Administration ("Marad") on the draft Environmental Impact Statement (MA-EIS-7302-75022-D) released on May 2, 1975, relating to the Title XI financing program for the private construction of offshore oil and gas drilling and service vessels (the "EIS").

Our comments on the EIS are submitted on behalf of the Environmental Defense Fund, the Natural Resources Defense Council, and the National Parks and Conservation Association. These national environmental organizations have a total membership of approximately 100,000 persons, and each was a plaintiff in a lawsuit which led to Marad's preparation of an environmental impact statement relating to its tanker construction program (Environmental Defense Fund v. Peterson, D.D.C. Civil Action No. 2164-72). In addition, these organizations have taken a continuing and active interest in Marad's other programs, as well as in the subject of marine pollution generally.

Summary of Comments

(1) The EIS does not provide enough factual information on the Marad financing program to enable an understanding of its operations, thereby making it difficult to determine whether the program should continue, and if so, in what form.

(2) The EIS' treatment of the environmental impact of offshore drilling and service vessels is overly general. There is insufficient information to assess oil-spill effects from drilling and service vessels, and almost no discussion of non-spill impacts. The analysis ought to be focused on the impacts of the particular vessels with which we are concerned as opposed to general data on the effects of oil on the marine environment, and on the relationship of vessels to different physical conditions. Quantification of environmental impacts is ignored, and ought to be addressed.

(3) The EIS fails to consider current and possible future safety design features of offshore drilling and service vessels. As a result, it cannot and does not compare the environmental safety of various rig types, or analyze design alternatives.

(4) The EIS is inadequate in its review of alternatives to the Marad program, both alternatives to offshore development generally and to the particular Title XI financing program.

(1) The EIS Fails to Explain the Operation of the Marad Financing Program

Initially, the EIS should clearly and precisely describe the workings of the Title XI program itself; the brief account included in the EIS gives no sense of the program's operation. Numerous questions arise: What application procedure is involved and what information is called for from an applicant? How much time is required to process an application? What criteria are considered in the decision whether to grant assistance? How important is the Title XI program in the overall construction of rigs? What proportion of all U.S.-built rigs is aided? Has Marad financing been significant in causing vessels to be constructed in the U.S.? How important has the Title XI program been to OCS development generally? What are the projections of the program's future growth and significance?

Without adequate information on the program's nature, dimensions, and effects, it is difficult to assess either its impacts or alternatives to it. Because of this deficiency, followed by a dearth of facts and analysis elsewhere in the body of the EIS regarding impacts and alternatives, no reasoned determination can be made whether, and if so, how, to continue the program. Thus, the EIS fails in its role under the National Environmental Policy Act of 1969 ("NEPA") as an aid in the decisionmaking process.

(2) <u>The EIS Fails to Adequately Evaluate the Impact of Drilling and Service Vessels Upon the Environment</u>

The EIS, in setting out the environmental impact of OCS drilling, servicing and support operations, refers to other environmental impact statements for analyses and then sets out a "general survey of environmental impacts" (III-3). More than this "general survey" is necessary.

The EIS discusses the impact of oil generally on the marine environment, but avoids both site- and vessel-specific analysis, and does not address the issue of varying impacts of different size spills. Since environmental impacts will differ enormously based on these factors, the EIS should approach the problem in specific, situational terms. It is key to relate spill probabilities and spill sizes to the different vessel varieties. Although the EIS purports to cover the environmental impacts of both drilling and service vessels, there is very little differentiation of the impacts of the different vessels, and minimal information on the effects of service vessels is supplied.

The overly general nature of the EIS also results in an avoidance of those impacts of drilling and service vessels which are neither immediate nor obvious. Little attention is directed to the long-term effects of using the vessels. The environmental impacts of chronic discharges of substances other than oil are mentioned but not adequately analyzed; although

such discharges are said to have a 100% chance of occurring and may be as damaging as accidental oil spills (III-24), the actual impacts of chemical substances in drilling muds, drill cuttings and other discharges are not discussed, but merely mentioned as being "significant" or not; some impacts are listed as "unknown" (III-9).*

The EIS discusses the environmental impacts of shipyard expansion, but does not explore the circumstances under which expansion would be required, nor the probability of the requirement. There is merely a conclusory statement that the present capability of the industry is "adequate", and that "an unexpected political or economic emergency may accelerate these programs; and the expansion of ship building facilities may become a necessity " (III-58). The EIS gives no indication as to the limitations of existing shipyards, and since the continuing effects of the Title XI program and projected requirements for drilling and service vessels are not set out, no projection is possible. The EIS should discuss the specifics of shipyard expansion: What are the current limitations and what is their relation to existing and future needs? What circumstances will require some sort of shipyard expansion? Will expansion require construction of new facilities, where would they be located, and what would their impact be?

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* To the extent that the impacts are not known, and, for example, the biological effects of drilling mud additives may not be well understood, it is incumbent on the drafters of the EIS, here as elsewhere, to specify remedies for the lack of knowledge.

Finally, quantification of possible damage is omitted from the EIS; much more extensive discussion of the probable costs resulting from spills or other conditions associated with the use of drilling and service vessels is required. Impacts are more adequately assessed and often more readily understood if their dollar costs are set out.*

(3) The Marad EIS is Inadequate in its Comparison of the Environmental Consequences of Existing Drilling Rig Designs and in its Consideration of Alternative Rig Designs and Equipment

(a) Comparison of Current Rig Designs

Perhaps the central element of the EIS should be the assessment of the environmental soundness of current designs. Unfortunately, Marad, based on the erroneous assumption that there is no information on the environmental soundness of different vessels, does not make such an assessment.

In order to assess the impact of the program, the various types of offshore drilling vessels (e.g., jack-up drill unit, surface floating, semi-submersibles) can and should be compared, not only in terms of their technical and operational characteristics, as they are in the EIS, but also for their safety devices and past safety records. There is very

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* Various other deficiences are found in the EIS treatment of enviromental impacts, including: the environmental impacts of onshore treatment and storage facilities are not handled in the analysis of secondary impacts; the socioeconomic impacts of the operations are inadequately considered; and possible impacts of offshore drilling on commercial and sport fishing and recreation are unassessed.

little individual evaluation of the environmental soundness of vessels, and no comparison at all. In its description of vessels, the EIS notes, in separate sections, that surface floating drilling ships and barges are the most widely used type of vessel, and that the disadvantages of this type of vessel limit their use to "areas having generally favorable conditions." (I-25). Wave action can cause the operations to be "inefficient or hazardous" (I-25). The EIS later states that these deficiencies have led to improvements in equipment and technique, but the problems apparently remain, the disadvantages being "inherent in a surface floating vessel." The advantages of the jack-up drilling unit are set out but seem to be focused more on economic and technical efficiency than environmental concerns. These analyses are insufficient; it is essential that the decisionmaker and the public know which vessels are safer under what circumstances or whether there are vessels which are generally more environmentally sound.

A comparison of the different vessel varieties of a single type (e.g., within the category semi-submersibles) is also necessary. It is not apparent from the discussion in the EIS whether different construction patterns are used, or whether there is any design standardization among various companies. Information on individual design features would seem essential to informed decisions on vessel financing, and should be included in the EIS. In its failure to include these facts and its general lack of assessment of rig designs, the Marad EIS fails in its most essential purpose.

(b) Consideration of Alternative Rig Designs and Equipment

Despite fleeting recognitions of the inadequacy of current technology, the EIS does not explore the proposition that some technologies for OCS drilling and service vessels might be more environmentall sound than those presently employed or that further study on this subject is needed before construction and drilling should proceed. This failure is unjustifiable.

At certain points in the text, the EIS indicates that current technologies may be inadequate and can be improved. There is an admission that the 1969 Santa Barbara spill "raised serious questions on the adequacy of OCS technology," (III-11), and the EIS reproduces a table showing that although the number of spills decreased from 1971 to 1972, their volume more than doubled (111-15).* In assessing the environmental impact of OCS drilling, servicing and support operations, Marad notes that data on oil spills during 1971 and 1972 suggest that "the same processes, equipment inadequacies, and operator errors are causing the spills" (111-16). A study conducted by Computer Services Corporation and included in the EIS also suggests that the number and size of oil spills could be significantly reduced by technological and operational improvements (III-16).

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* The lack of incentives to report drilling accidents may even mean that spills are more numerous.

Yet these indications that technologies may be inadequate, do not lead, as they should, to an analysis in the EIS of possible problems or improvements. The EIS states: "Little is being done in the areas of the design of offshore equipment to prevent pollution" (V-6), but the statement only results in the offhand observation that increased research and development is necessary, and the EIS' basic conclusion seems to be: "It is questionable whether such a course of action [an attempt to devise stricter environmental standards] would result in standards materially different than those presently in effect" (V-5).

Marad's failure to consider rig design features that could minimize pollution is at least partially based on industry's identification of human error as the primary problem producing accidents. The EIS states: "the types of pollution which pose the most threat are those associated with the drilling process" (V-5). However, Marad needs to explore the other accident-causing factors, and to recognize that increased attention to rig design could aid in solving "process" weaknesses. Drilling process dangers are not dissociated from the improvement of safety factors of the equipment used to do the drilling. Rather, dangers centered on human error make equipment perfection all the more essential. The search for improved technology must include an increased understanding of human criteria in equipment design, with an emphasis on the development of fail-safe systems and techniques.

Contrary to Marad's pessimistic assumptions, the EIS seems particularly well suited to a consideration of methods of decreasing adverse environmental impacts of OCS operations through the use of more efficient equipment and procedures. If information is indeed lacking, then there should be analysis of why the assessment information is lacking, and what time and other factors are involved in its compilation. Postponement of OCS leasing until the best available technology is being employed by all, or until the technology can meet the particular safety problems of different areas, must be seriously considered, not summarily treated as it now is, based upon professed lack of knowledge.

The revision of current standards governing vessel design is certainly one alternative that should be examined. It is wrong to presume design adequacy, as the EIS does, from the fact that vessels covered under the Title XI program are acceptable under present standards. As noted authorities on the subject of OCS operations have said: "In a narrow sense, the problem of technological inadequacy can be related to the generally permissive nature of government regulations on the OCS... the OCS regulations have always been well within the state of the art as practiced by the industry so that compliance has presented no serious technical challenge". See Kash, et al., Energy Under the Oceans 113 (1973) (hereinafter cited as "Energy"). Since

technological improvements have normally occurred because of the pressure of government regulation (Energy, p. 123), the alternative of stricter government standards should not be so easily dismissed. Regulations since the Santa Barbara spill have become more specific, presumably with beneficial results, and there appear to be sound reasons to continue this trend.

In fact, there appear to be specific technological improvements which could enhance the environmental soundness of Marad-financed vessels. While it is recognized that it is unrealistic to exclude the possibility of drilling or blowout accidents (Energy, p. 117), various changes may be desirable and have been outlined in other texts.* The draft environmental impact statement prepared by the U.S. Geological Survey for the offshore development of the Santa Ynez Unit also enumerated types of drilling equipment and procedures that lessen the probability of a blowout. See U.S. Dept. of the Interior - U.S. Geological Survey, Draft Environmental Statement--Proposed Plan of Development of Santa Ynez Unit, IV-113f (DES 73-45)(1973). Such concrete alternatives must be fully assessed in the EIS.

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* Desirable changes in drilling and blowout control technologies set out in Energy, pp. 117-18, include longer-lasting bits, improved downhole instrumentation and mud monitoring systems to facilitate identification of potential blowouts, separation of wellheads, fail-safe design of multi-well platforms, control consoles for blowout preventer sacks, and survivable event recorders.

(4) The EIS Also Fails to Review Alternatives to the Marad Program Not Involving Alternative Vessel Design and Equipment

Although the EIS approaches the issue of alternatives correctly in terms of addressing both alternatives to offshore development in general and alternatives to the Marad financing program, the discussion is inadequate both in exploring possible alternatives and in discussing their impacts. While it could be argued that less attention should be directed at alternatives to offshore drilling in an environmental impact statement on rig financing, this program involves government sponsorship of OCS development, and such an argument, if accepted, can only lead to a continual failure to examine these alternatives. The existing discussion of alternatives is so general that it is useless -- a mere six page "analysis" is quite out of proportion in an environmental impact statement that should include a meaningful exploration of alternatives.

(a) Alternatives to OCS Development

As an alternative to offshore development, conservation is fleetingly mentioned, and other alternatives are merely listed. A Department of the Interior analysis of alternatives is cited but not discussed; at least the major points of this analysis should be included in the text of the EIS.

Marad needs to explore the impacts that would be involved in discontinuing OCS development, particularly in terms of possible substitution of energy sources. It continues to be apparent that the adoption of an integrated national energy policy requires consideration.

(b) Alternatives to the Marad Program

The EIS presumes that any delay or discontinuance of the Marad program would automatically result in the use of either privately financed or foreign vessels, and that this would involve decreased control and therefore less safe vessels. But such presumptions cannot be accepted before the facts are inquired into and analyzed.. The EIS should include information on the availability of such vessels, their costs, and their safety characteristics in relation to Marad requirements. The presumption that control would be diminished needs to be investigated. The EIS ignores the possibility that postponement or discontinuance could include a program of regulation of privately financed or foreign vessels, perhaps one involving stricter standards.

Marad's assumption that drilling process factors cause the most danger was previously explored in this comment in terms of design improvements which could eliminate the process dangers. Increased focus on these process-associated dangers

should also include attention to personnel training and supervision. Formalized training programs need to be established and accredited, which will initially require definition and standardization of operating procedures. The training programs' content should in turn be standardized and made universal by a requirement of personnel certification. Later supervision of methods and constant evaluation of procedures could complete the program. Marad should consider whether the formalization of programs and their supervision could be done by Marad itself, or whether other agencies should be added or substituted to assure an efficient system. If it is true that dangers associated with the drilling process are the most critical, certainly these steps should at least be considered.

Another area in which alternatives may be possible is the supervision of operations and enforcement of government regulations. Possible inadequacies are not considered by the EIS -- there should at least be an open assessment of whether supervisory needs are satisfied. Prior to the Santa Barbara spill, enforcement tended to be lax and waivers were easily obtained, and if this reflects the current situation, action should be taken which could involve supervision by different or additional agencies.

In relation to all program alternatives, the importance of government research and development must be stressed.

Government sponsorship of research and development for OCS-related activities is minimal compared to its support of research and development in other areas, and industry investment itself is fairly low. Particularly with the expansion of OCS development into the Atlantic Ocean, the Gulf of Alaska, and deeper water, the need for increased sponsorship is manifest: these moves create more severe threats to the environment from amplified storm and seismic conditions, and generally changed circumstances in deeper water. (Energy, p. 117). For example, research aimed at identifying and reducing impacts of chronic discharge is particularly needed, and a program for such study should be proposed.* Government should increase its own technical knowledge in order to meet the challenge of developing improved technologies; it needs to achieve an information-gathering function, and possibly to coordinate with private industry in this regard. Formal government systems that will enable identification of equipment and procedural deficiencies and provide for their correction are essential. Ways to develop such systems should be explored in depth in the EIS.

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* It may be within the state of the art to reduce the discharges by minimal improvements of existing technology or merely by increased attention to procedures. 1 OCS Oil and Gas - An Environmental Assessment: a Report to the President by the Council on Environmental Quality 42 (April 1974).

Conclusion

The failure of the EIS to evaluate fully the environmental impact of and alternatives to the Marad vessel financing program renders it inadequate under NEPA. The EIS requires substantial revision to meet NEPA's requirements, and, as a matter of sound policy, to ensure that, if the program continues, subsidized vessels are designed, constructed and operated in the most environmentally sound manner.

If you have any questions concerning these comments, please do not hesitate to contact the undersigned.

Sincerely,

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Center for Law and Social Policy

The comments received from this organization were submitted on behalf of three environmental groups and consist primarily of outlining alleged inadequatness of the draft environmental impact statement. Responses to the comments are as follows and begin with page 3 item (1) of their letter dated 20 June 1975:

(1) The EIS Fails to Explain the Operation of the MarAd Financing Program

The comments contained on page 3 under this general heading have been resolved in the most part by rewriting Chapter I which now reflects the Title XI Program in detail and its application to offshore drilling vessels.

(2) The EIS Fails to Adequately Evaluate the Impact of Drilling and Service Vessels Upon the Environment

Under this general heading the comments cover a wide spectrum from page 4 to 6. Beginning with paragraph one of page 4, item 2, the response to each comment follows:

Page 4, para. 1 - Referring the reader to other environmental impact statements for analysis has been removed, and Chapter III has been completely restructured to afford a more descriptive and analytical assessment of the marine environment.

Page 4, para. 2 - To endeavor to relate spill probabilities and spill sizes to the different vessel varieties would have no significance. Each oil and gas drilling vessel, regardless of its configuration, has the same equipment which is designed to bore an exploratory hole in the OCS. However, Chapter III now reflects the impact of natural occurrences such as earthquakes on the different vessel varieties. A drilling vessel (when not actually drilling) and a service vessel generate similar impacts on the environment by the emission of engine exhaust fumes, sewage, wastes and bilge discharges. These impacts are addressed in Chapter III under 'Other Vessel Generated Pollutants."

Page 4-5, para. 3 - Chapter III has been rewritten and now reflects a more detailed description and analysis of environmental impacts of chronic discharges into the marine environment.

Pages 5-6, para. 4 - The possibility of shipyard expansion as a result of the Title XI program has been addressed on page III- 77.

(3) The MarAd EIS is Inadequate in its Comparison of the Environmental Consequences of Existing Drilling Rig Designs and its Consideration of Alternative Rig Designs and Equipment

(a) Comparison of Current Rig Designs

From page six to twelve inclusive comments are made requiring a comparison of the different types of offshore drilling vessels to show past safety records, safety devices and environmental soundness of each design. Responses to these comments are as follows:

Pages 6-7, para. 1-3 - To compare the different designs of offshore drilling vessels for environmental soundness and safety devices is to say that one design is less safe and could cause greater environmental harm than another design. This is not the case, for each type of vessel, whether it is a jack-up drill unit, surface floating or semi-submersible must meet the rigid construction and operational standards that are discussed in Chapter IV, both from a safety as well as environmentally sound standpoint.

There are no known casualties of any design associated with the offshore drilling vessels constructed under the Title XI program.

A footnote at the bottom of page 6 states that other deficiencies were found in the draft EIS treatment of environmental impacts. These have been considered together with paragraph 3 on page 7 and, where appropriate, have been addressed in the revision of Chapters I and III.

Page 7, para. 4 - Information on individual design features is essential and is evaluated at the time an applicant applies for a Title XI financing guarantee. This is discussed in the revised version of Chapter I.

(b) Consideration of Alternative Rig Designs and Equipment

Under this sub-heading the comments also imply that some OCS drilling and service vessels are less environmentally sound than others. It is reiterated that such is not the case as all vessels constructed and operated under the Title XI program must meet the rigid standards that are discussed in Chapter IV.

The second paragraph on page eight refers to the 1969 Santa Barbara spill and the adequacy of OCS technology at the time of this spill. Page III-12.

indicates that on December 11, 1973 the California State Lands Commission unanimously adopted a staff report indicating that the oil industry had developed safety equipment and procedures that minimized the possibility of a major oil spill occurring and lifted a moritorium on new drilling on existing state tidelands leases.

Comments relative to the number of oil spills also on page eight, are responded to in a Department of the Interior comment - "Another reason for the apparent lack of significant decrease in the number of pollution incidents (p. III-13, paragraph 2) is the improvement in recording and reporting practices."

Page 9, para. 1 - Chapter V has been revised to show that private industry has and is continuing to take steps in the design of equipment and systems to prevent pollution.

Page 9, para. 2 - The Department of the Interior in its detailed comments included herein, contend that the proposed alternative of modifying the program by giving preference to certain vessel designs that are more environmentally sound than others (p. V-4 to V-5) appears not to be a real alternative but to be a part of the MarAd Title XI program as presently administered. This contention has been concurred in and Chapter V has been revised accordingly.

Page 10, para. 1 - The comment implies that the equipment and procedures used by the Title XI drilling vessels are inefficient, whereas the contrary is true. It is a known fact that the standards for equipment and operating procedures of these vessels are among the highest in the world and have been copied by other nations.

Page 10, para. 2 - The comments contained on pages 10 and 11 are based on abstracts from the book "Energy Under the Oceans" by D. E. Kash and others. The abstracts are taken from Chapter VI entitled "Adequacy of OCS Technologies" in which the abstracts quoted are somewhat critical. In making the comments, that are based strictly on requiring improved OCS drilling technology the Summary to Chapter VI has been ignored. This, in part states - "The significant improvements in the use of failure analysis, component redundancy, and system design which have taken place in other technical fields in the past twenty years have been applied only recently to the OCS oil industry. The industry has substituted a hit-or-miss program of operator training for a true human-factors approach to

design and to the development of methods for measuring and displaying vital information to the tool pusher and production supervisor.

Industry representatives rightly point out that some recent wells have been drilled to record depths and in particular adverse conditions using truly impressive equipment monitored through computer programs and embodying up-to-date fail-safe concepts." --

It is within the frame-work of the above quotes that the Title XI program vessels are built and operated.

(4) The EIS also Fails to Review Alternatives to the MarAd Program Not Involving Alternative Vessel Design and Equipment

Under this general heading comments are submitted relative to Chapter V - Alternatives to the Title XI Offshore Oil and Gas Drilling Program. Responses to these comments are as follows:

Page 12 (a) Alternatives to OCS Development

As a result of comments also submitted by others Chapter V has been restructured and now contains the major points of the Department of the Interior analysis of energy alternatives including conservation.

Page 13 (b) Alternatives to the MarAd Program

The comment that - "The EIS presumes that any delay or discontinuance of the MarAd program would automatically result in the use of either privately financed or foreign vessels, and this would involve decreased control and therefore less safe vessels."

The EIS does not state that this would happen, only that it was a possibility that should be considered. To claim that it would happen is to draw conclusions that do not belong in an environmental impact statement.

Page 14 - The comments on this page are concerned primarily with establishing training and supervision requirements. Response to these comments are found in Energy Under the Oceans by Kash et. al., in the summary on page 122 which, as previously mentioned, states - "The industry has substituted a hit-or-miss program of operator training for a true human-factors approach to design and to the development of methods for measuring and displaying vital information to the tool pusher and production supervisor."

It is believed that it was not the intent, or the desire of NEPA for the Federal government to interfere with private industry under such a program as that of Title XI loan guarantees.

Page 15 - Comments on this page further discuss the need for government sponsored research and development programs related to OCS technology. Response to these comments are taken from "An Analysis of the Feasibility of Separating Exploration from Production of Oil and Gas on the Outer Continental Shelf" by the Congress of the United States - Office of Technology Assessment, dated May 1975.

Page 240 - Research and Development to Improve Technology for OCS Development

The Secretary of the Interior is, under S. 3221, directed to carry out a research and development program designed to improve technology related to development of oil and gas resources of the OCS. Areas of investigation shall include: downhole safety devices, methods for re-establishing control of blowing out or burning wells, methods for containing and cleaning up oil spills, new or improved methods of development in water depths over 600 meters, and subsea production systems.

APPENDIX A

THE RELATIVE HARMFUL EFFECTS OF LIGHT AND HEAVY OILS

THE RELATIVE HARMFUL EFFECTS OF LIGHT AND HEAVY OILS

Introduction

The International Convention for the Prevention of Pollution of the Sea by Oil (1954) as amended, controls the discharge from tankers of the so-called black or heavy oils (crude oil, residual fuel oil, heavy diesel, etc.). Light oils (No. 2 fuel oil, jet fuel, gasoline, etc.) were not included in the Convention and their discharges into the sea are not controlled. However, the U.S. Environmental Protection Agency has investigated both the impact of light oils into the world ocean from tanker operations (1) and the relative effects of refined products and crude oil (2). These studies show that light oils are discharged from tankers in sufficient quantity and in such a manner as to have potential harmful effects on the marine environment. They also indicate that light oils are substantially more toxic to marine life and potentially more harmful than heavy oils. Hence, the IMCO Marine Pollution Conference of 1973 determined that light petroleum derived oils will be subject to at least the same stringent regulations imposed on crude oil and heavy petroleum products.

In a continuing effort to evaluate the relative harmful effects of petroleum products to aquatic organisms as set forth by Resolution No. 6 of the Marine Pollution Conference of 1973 (MP/CONF/WP. 46), the U.S. EPA has to date conducted original investigations to determine the acute toxicity of six petroleum products to four test organisms; also, selected physicochemical properties of water emulsions of the selected oils have been determined. Additionally, a thorough literature review has been conducted to further elucidate the relative effects of different refined fractions of crude oil. Future studies will concentrate on the relative effects of oils on specific biological processes occurring in the pelagic environment.

The immediate result of these investigations is an updated relative hazards profile of the type introduced in a previous document (2). The present profile is directed in consideration to phenomena occurring in the open ocean (pelagic) ecosystem and limited in scope to acute toxicity, inhibition of photosynthesis, bioaccumulation and carcinogenicity, accomodation and persistence, and chemical communication.

Acute toxicity

During the past year, the U. S. EPA has completed a program of acute toxicity bioassays with four organisms and six petroleum products. The organisms tested include the menhaden, *Brevoortia patronus*; the mullet, *Mugil cephalus*; the shrimp, *Palaemonetes vulgaris*; and the sunfish, *Lepomis macrochirus*. The petroleum products tested include a Louisiana crude oil, a No. 6 fuel oil, a No. 2 fuel oil, a jet fuel, and a leaded and an unleaded gasoline.

Procedures

The static bioassays were conducted according to the general principles and methods set forth in *Standard Methods for the Examination of Water and Waste Water* (3). High speed blending was experimentally determined to produce the most stable oil in water dispersion and was therefore chosen as the method of mixing. The concentration of oil in the water column was determined daily by means of infrared spectroscopy (4) and TL_m^{96} (96 hr. median tolerance limit) values were computed on this basis. Fish mortality and behavior were observed several times each day and tolerance limits were estimated by straightline graphic interpolation using the total concentration of oil added and the actual concentration of oil in the water column. Dissolved oxygen concentration, temperature

and pH were monitored daily. The results below are based on the amount of oil actually found to be present in the water column at the initiation of the assay. A dash indicates that no test was conducted.

Menhaden

The tolerance of juvenile menhaden to the six petroleum products has been determined and the results are presented in Table 1.

TABLE 1

Test Material	TL_m^{96} (mg/l)
leaded gasoline	2
unleaded gasoline	-
fuel oil No. 2	5
jet fuel	2.1
crude oil	5
fuel oil No. 6	10

Mullet

The tolerance of juvenile mullet to the six petroleum products is summarized in Table 2.

TABLE 2

Test Material	TL_m^{96} (mg/l)
leaded gasoline	4
unleaded gasoline	2
fuel oil No. 2	13
jet fuel	45
crude oil	56
fuel oil No. 6	-

Shrimp

The tolerance of the shrimp *Palaemonetes vulgaris* to the petroleum products is presented in Table 3.

TABLE 3

Test Material	96 TL (mg/l) m
leaded gasoline	1
unleaded gasoline	1
fuel oil No. 2	2
jet fuel	4
crude oil	15
fuel oil No. 6	25

Sunfish

The tolerance of juvenile sunfish, *Lepomis macrochirus*, to the six petroleum products is presented in Table 4.

TABLE 4

Test Material	96 TL (mg/l) m
leaded gasoline	7
unleaded gasoline	7
fuel oil No. 2	95
jet fuel	100
crude oil	160
fuel oil No. 6	127

As can be seen from the above results, there is substantial variation in the tolerance of the tested organisms to all of the

petroleum products tested. However, the phenomenon of higher relative toxicity of the lighter oils is consistent among the species tested. This is illustrated graphically in Figure 1.

Only a few other studies have been conducted which measured the relative toxicity of petroleum products to aquatic organisms. Although the amounts determined to cause a particular toxicity vary according to the experimental methods employed and the characteristics of the specific products used, there is general agreement as to the relative toxicity of heavy versus light oils in these static bioassays.

Anderson et.al.(5) tested the toxicity of the water soluble fractions and oil in water dispersions of four oils to six marine species. Two crude oils, a South Louisiana crude and a Kuwait crude, and two refined oils, No. 2 fuel oil and bunker C residual oil (No. 6 fuel oil), were used in these investigations. The test species were ranked according to increasing sensititivity to oil as follows: the sheepshead minnow, <u>Cyprinodon variegatus</u>; the tidewater silverside, <u>Menidia beryllinia</u>; the longnose killfish;

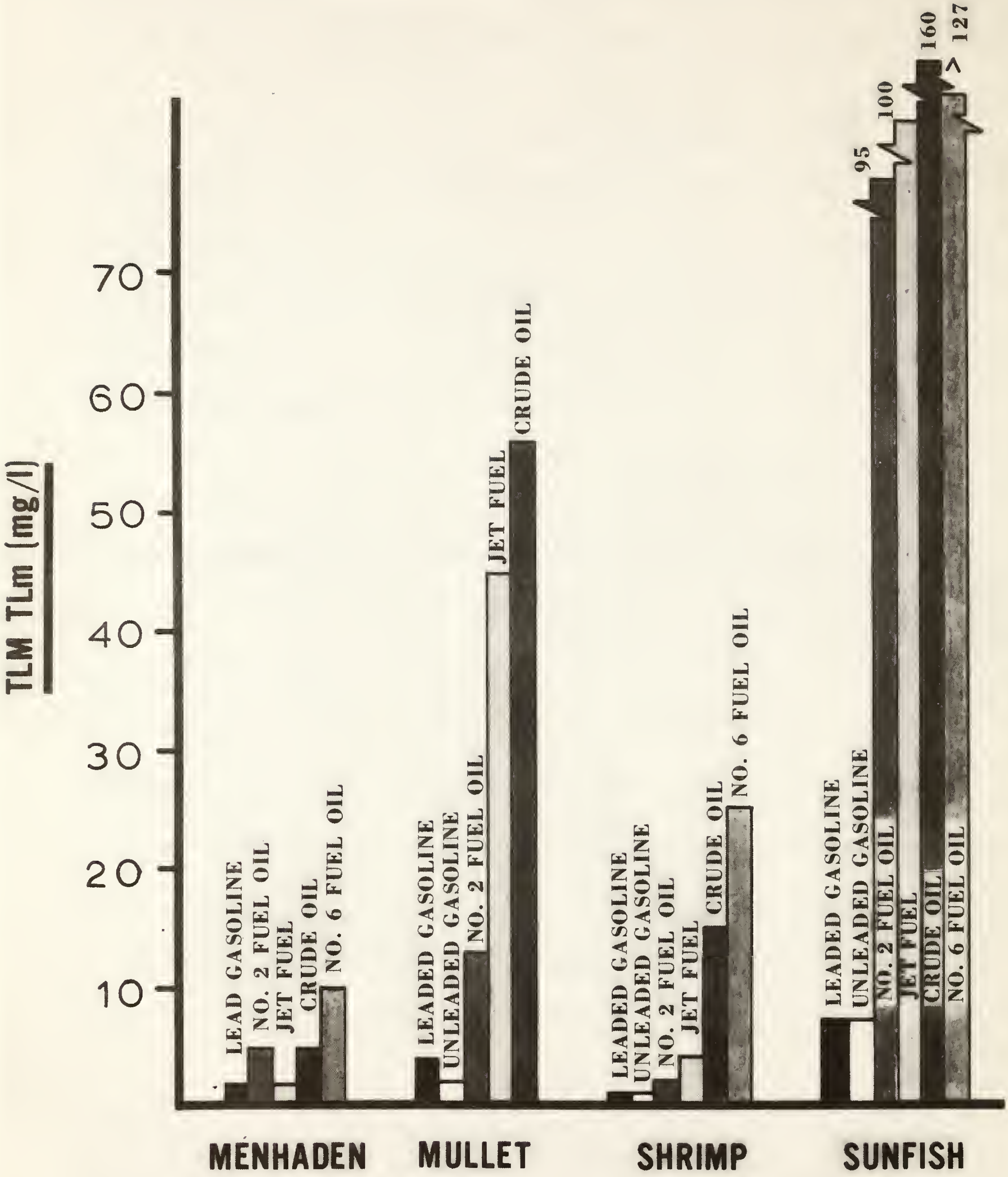

FIG. 1. RELATIVE TOXICITIES TO SELECTED SPECIES

Fundulus similus; the brown shrimp, *Penaeus aztecus* postlarvae; the grass shrimp, *Palaemonetes pugio* and the mysid, *Mysidopsis* almyra. The water soluble fractions and oil in water dispersions of the refined oils were considerably more toxic to the six test species than were those of the crude oils (Table 5).

Tagatx (6) tested the toxicity of gasoline, diesel fuel, and No. 6 fuel oil to juvenile American shad *Alosa sapidissima.* Gasoline was the most toxic, diesel fuel somewhat less toxic and bunker oil least toxic (Table 6). The lethality of petroleum products to shad was found to increase when accompanied by low dissolved oxygen.

Inhibition of Photosynthesis

As the process of photosynthesis by marine phytoplankton is responsible for the fixation of much of the energy utilized by marine ecosystems, determining what effect petroleum products have on this process is an important step in the evaluation of the relative potential harm of these products.

Gordon and Prouse (7) examined the effects of three oils (Venezuelan crude, No. 2 fuel, and No. 6 fuel) on the photosynthesis of natural phytoplankton communities from Bedford Basin, Nova Scotia, and the northwest Atlantic Ocean using a radiocarbon method.

TABLE 5. 48 Hour TLm values compiled from data presented by Anderson (1974).

Species	S. La. Crude *OWD	S. La. Crude **WSF	Bunker C OWD	Bunker C WSF	#2 Fuel Oil OWD	#2 Fuel Oil WSF
Sheepshead minnow	33,000	19.8	-	4.4	200	6.9
Tidewater silverside	5,000	8.7	-	2.7	125	5.2
Longnose killifish	6,000	16.8	-	2.27	36	4.7
Grass shrimp	1,650	16.8	-	2.8	3.4	4.1
Brown shrimp	1,000	19.8	-	3.5	9.4	5.0
Mysid	37.5	8.7	-	0.9	1.3	0.9

*OWD - Oil in water dispersion

**WSF - Water soluble fraction

Concentrations of OWD's are expressed as ppm oil added to the water, and of WSF's as ppm total oil hydrocarbons in the aqueous phase as determined by IR analysis.

Table 6. TL_m (median tolerance limit) values of gasoline, diesel fuel oil, and bunker oil for juvenile American shad, *Alosa sapidissima*. Tagatz (1961).

Product	TL (mg/l) 24 hour	48 hour	96 hour
Gasoline	91	91	-
Diesel fuel oil	204	167	-
Bunker oil	-	2,417	1,952

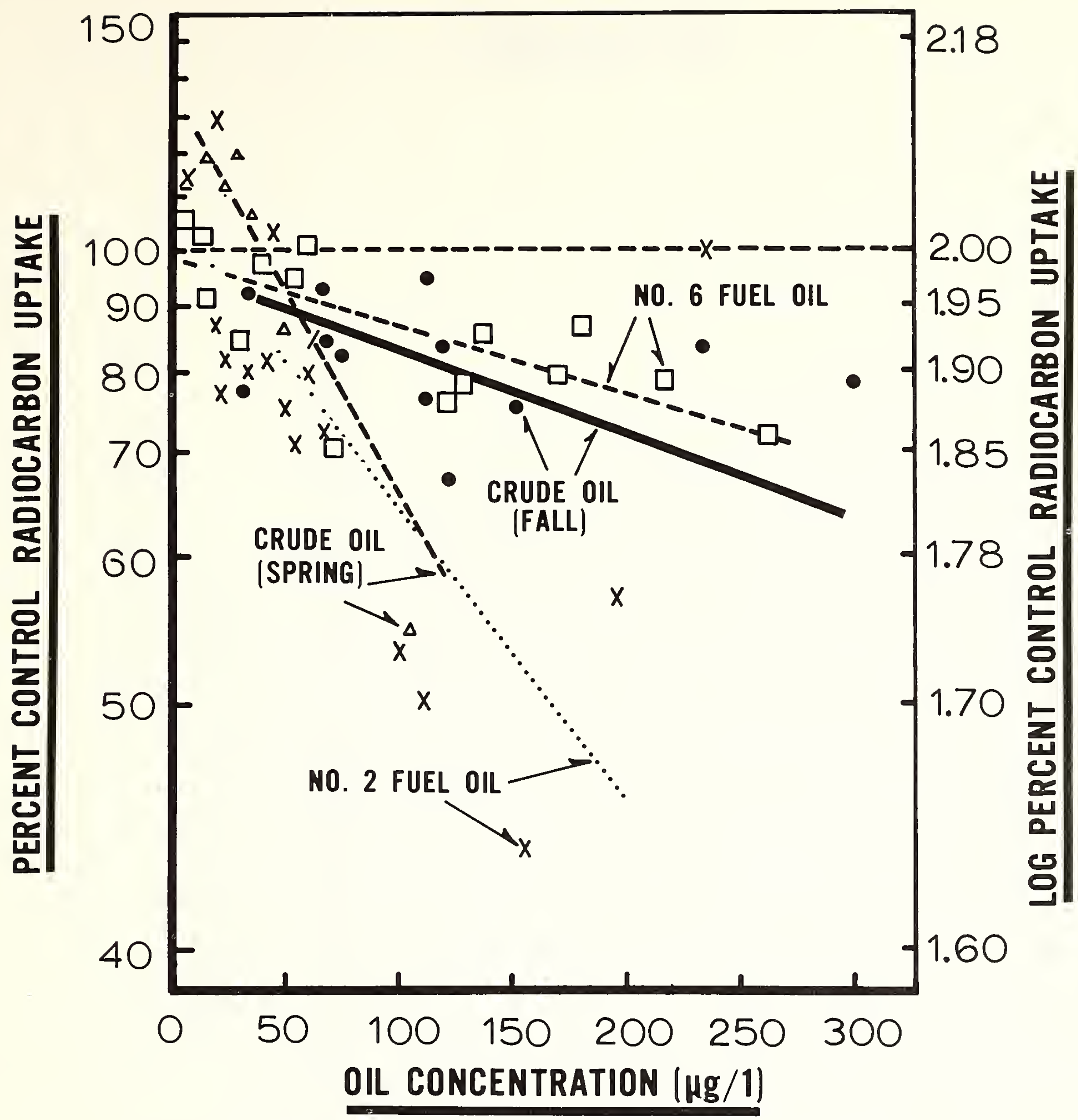

FIG. 2. DATA FROM BEDFORD BASIN EXPERIMENTS USING THE 3 OILS. THERE WAS NO SIGNIFICANT DIFFERENCE BETWEEN THE SPRING AND FALL DATA FOR THE NO. 2 AND NO. 6 FUEL OILS, SO DATA WAS COMBINED (Gordon and Prouse, 1973)

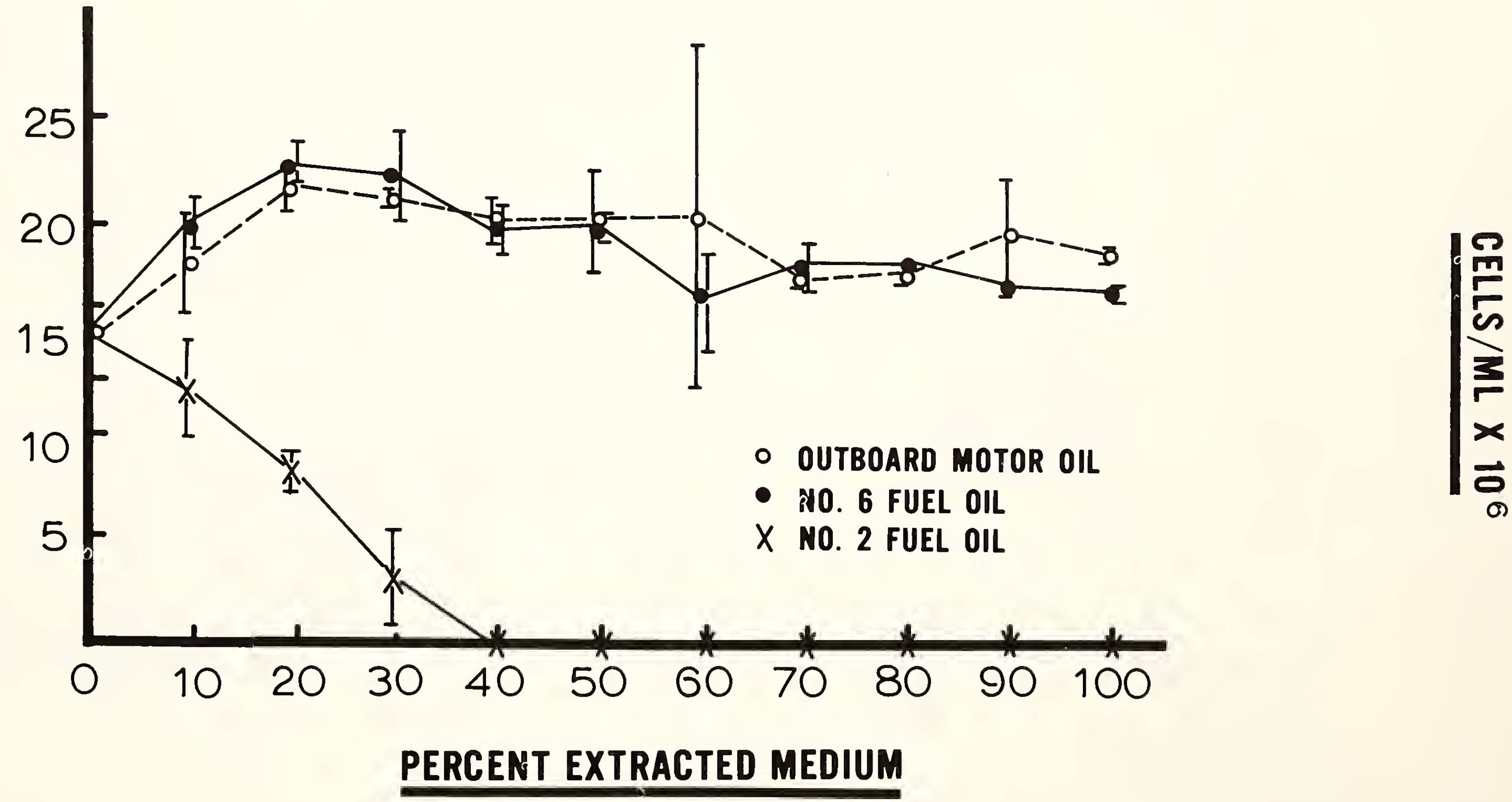

FIG.3. THE EFFECT OF WATER SOLUBLE EXTRACTS OF THREE TYPES OF OIL ON THE GROWTH OF PHAEODACTYLAM TRICORNUTUM IN DC MEDIUM ($p=0.05$) (NUZZI, 1973).

The three oils were found to be capable of inhibiting photosynthesis, the degree of inhibition increasing with concentration. Fuel oil #2 was the most inhibitory. The results of this study are summarized in Figure 2.

Nuzzi (8) studies the effects of No. 2 fuel oil, No. 6 fuel oil and outboard motor oil on the growth of marine phytoplankton. The growth of axenic cultures of Phaeodactylum tricornutum was most severely depressed by No. 2 fuel oil (Figure 3). Six fewer species were found in the natural cultures inoculated with No. 2 fuel oil than in those inoculated with No. 6 fuel oil or outboard motor oil (Table 7).

The effects of four petroleum products (No. 2 fuel oil, Bunker C, South Louisiana crude oil, Kuwait crude oil) on the carbon fixation rates of Monochrysis lutheri, a marine flagellate; and Chlamydomonas spp. were determined recently (9). A comparison of the data (Table 8) indicates a difference in susceptibility, Monochrysis being less resistant. The No. 2 fuel oil had a markedly greater inhibitory effect than either of the two crudes.

Table 7. Differential Cell Counts on Cultures of Natural Phytoplankton Populations to Which Water Soluble Extracts of Various Oils Were Added. A Dash Indicates That the Organism Was Not Found. (Nuzzi, 1973)

	Initial count (cells/ml)	Control (No Add)	No. 2 Oil	No. 6 Oil
Thalassionema nitzschoides	150	2,750	100	660
Licmophora sp.	100	-	150	-
Cerataulina bergona	760	21,870	-	10,780
Nitzschia closterium	-	710	-	560
Skeletonema costatum	-	510	-	610
Chaetocerus sp.	-	310	-	410
Navicula sp.	-	-	-	50
Gyrosigma sp.	-	-	-	50
Unidentified mu-flagellates	840	29,610	-	21,380

Table 8. Results of carbon-14 primary productivity experiments.

Data are expressed as concentration of contaminant that resulted in a 50 percent reduction in photosynthetic activity.

Concentrations in ug/ml.

Test Organism	No. 2 Fuel Oil Dispersed	No. 2 Fuel Oil Undispersed	South Louisiana Crude Oil Dispersed	South Louisiana Crude Oil Undispersed	Kuwait Crude Oil Dispersed	Kuwait Crude Oil Undispersed	Bunker C Dispersed	Bunker C Undispersed
Monochrysis	8.4	0.9	75	250	87			
Chlamydomonas spp.	50	7.2			250	550	575	575

The available scientific evidence clearly indicates that light oils inhibit phytoplankton photosynthesis to a greater degree than do heavy oils.

Bioaccumulation and Carcinogenicity

In considering the problem of the bioaccumulation and carcinogencity of petroleum products in the marine environment, at least three questions arise. Are marine organisms capable of accumulating petroleum hydrocarbons? If so, what effect might this have on the organism or the total system including man? Is there evidence to indicate that some products are more hazardous in these respects than others?

Mackie, et. al (10) studied the contamination of brown trout with diesel oil eleven days after a spillage had occurred in their environment. Both the fish after cooking and the hydrocarbon fraction isolated from the uncooked fish were found to smell and taste like the diesel fuel.

Burns and Teal (11) studied the hydrocarbon content of pelagic Sargassum weed and associated macrofauna. All the organisms were contaminated with petroleum hydrocarbons but there was no relation between the hydrocarbon content and the trophic status of the organism. The authors suggest that the main route of entry of petroleum hydrocarbons into the marine organisms was directly from the water across gills and other surfaces.

Conover (12) found that zooplankton ingested small particles of No. 6 fuel oil that were found dispersed throughout the water column after a tanker accident. As much as 10% of the oil in the water column was associated with zooplankton. This direct ingestion of petroleum facilitates biological concentration in commercially important fish species which feed on zooplankton. Also, this study found that the zooplankton feces contained up to 7% fuel oil. Hence the pathways for biological concentration are open for coprophagous as well as planktivorous species.

Blumer et. al.(13) investigated a spill of No. 2 fuel oil and found petroleum hydrocarbon contamination evident in two species of edible shellfish. The straight chain hydrocarbons were gradually depleted by a presumed biochemical modification but the more toxic aromatic hydrocarbons were retained in the organisms for several months.

Petroleum products are known to contain carcinogens, the best known being benzapyrene. Petroleum distillates used as lubricating or cutting oils have long been known to cause skin cancer in machine operators and may contain over 1% polycyclic aromatic hydrocarbons. The distillate fractions boiling between 300 degrees and 400 degrees Centigrade have been identified as containing the major carcinogenic activity of petroleum (14).

Lee et. al (15) studied the uptake of two carcinogenic petroleum hydrocarbons in three species of marine fish and found rapid uptake with subsequent partial metabolism and discharge. He also reported that anchovies and smelt from a petroleum polluted environment contained up to 10 mg. of benzapyrene per fish with lesser amounts of several other unidentified aromatic hydrocarbons.

In a recent survey at the site of a No. 2 fuel oil spill, histopathological examination of softshell clams, _Mya arenaria_, found cancer of gonadal tissue origin which had spread throughout the organism (16). The incidence of cancer was a high as 22% at some of the stations. Two areas with maximum contamination correlate directly with those sampling sites where the highest incidence of cancer was found. However, synergistic interactions cannot be ruled out because of other sources of stress in the area.

Thus, it has been clearly demonstrated that marine organisms can accumulate and concentrate petroleum hydrocarbons, especially the more toxic aromatic components and the known carcinogens. Although no cases of human cancer have been linked to petroleum products disposed of in the marine environment, the potential may exist. At least in one case, a direct correlation has been shown between light oil contamination and cancer in a commercially important human food species.

Accomodation and Persistence

As used herein, accomodation is defined as a process whereby petroleum is made miscible with water and includes solubilization,

micelle formation, chelation, etc. Recent works (17, 18, 19) indicate that the accomodation of petroleum products in marine waters is dependent upon such factors as mixing energy, temperature, salinity and dissolved organic matter present.

The original investigations of the U.S. EPA into the relative properties of various petroleum products considered the interactions of accomodation and persistence as related to laboratory conditions encountered in a static bioassay. Although the results of these experiments cannot be applied in a direct manner to pelagic ecosystems, they are valuable in assessing the relative interactions of the various products with sea water.

Since toxicity, as measured by bioassay is time/concentration dependent, an experiment was conducted to determine the short-term persistence of the various products in the water column. Although an equal volume of product was added to each experimental tank, there was an initial difference in water column concentration due to losses during mixing and differences in solubility with some free oil remaining on the water surface. The results as presented in Figure 4 show that, of that fraction entrained in the water column; No. 2 fuel oil is more persistent, remaining above 10% after weathering for one week. Jet fuel and No. 6 fuel oil, initially declined below

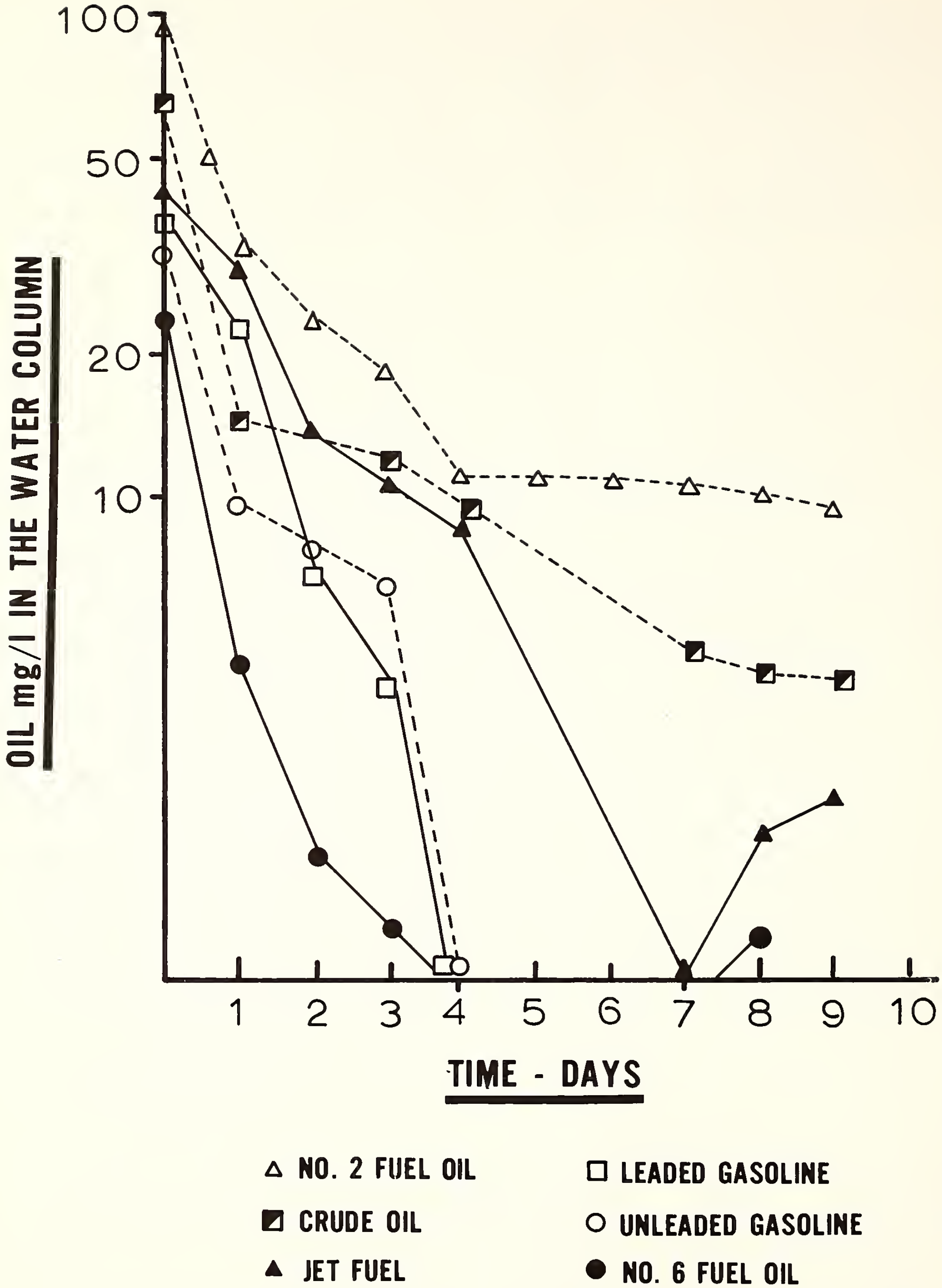

FIG. 4. SHORT-TERM PERSISTENCE OF A CRUDE OIL AND CERTAIN PETROLEUM REFINERY PRODUCTS IN THE WATER COLUMM IN OPEN SYSTEMS

the limits of analysis then increased in concentration. This apparent paradox might be due to increased bacterial solubilization of the surface layer as microbial populations increased.

Frankenfeld (20) found a similar trend in his investigation of the weathering of No. 2 fuel oil, No. 6 fuel oil and Venezuelan crude under simulated natural conditions. After a week's weathering in laboratory simulators, the dissolved fraction of the No. 6 fuel oil was approximately 3.5 times that found for the heavy oils (Figure 5).

The above evidence belies that idea that light oils disappear shortly after being introduced into the marine environment. Since the soluble fraction of most petroleum products consists mainly of medium weight aromatics and this fraction contains those compounds known to be the most toxic, persistence of the soluble fraction is an important property to consider in determining the relative harmful effects of petroleum products. The above evidence indicates that light oils are accomodated by sea water more readily than are heavy oils and that light oils persist in the water column whereas heavy oils form surface slicks.

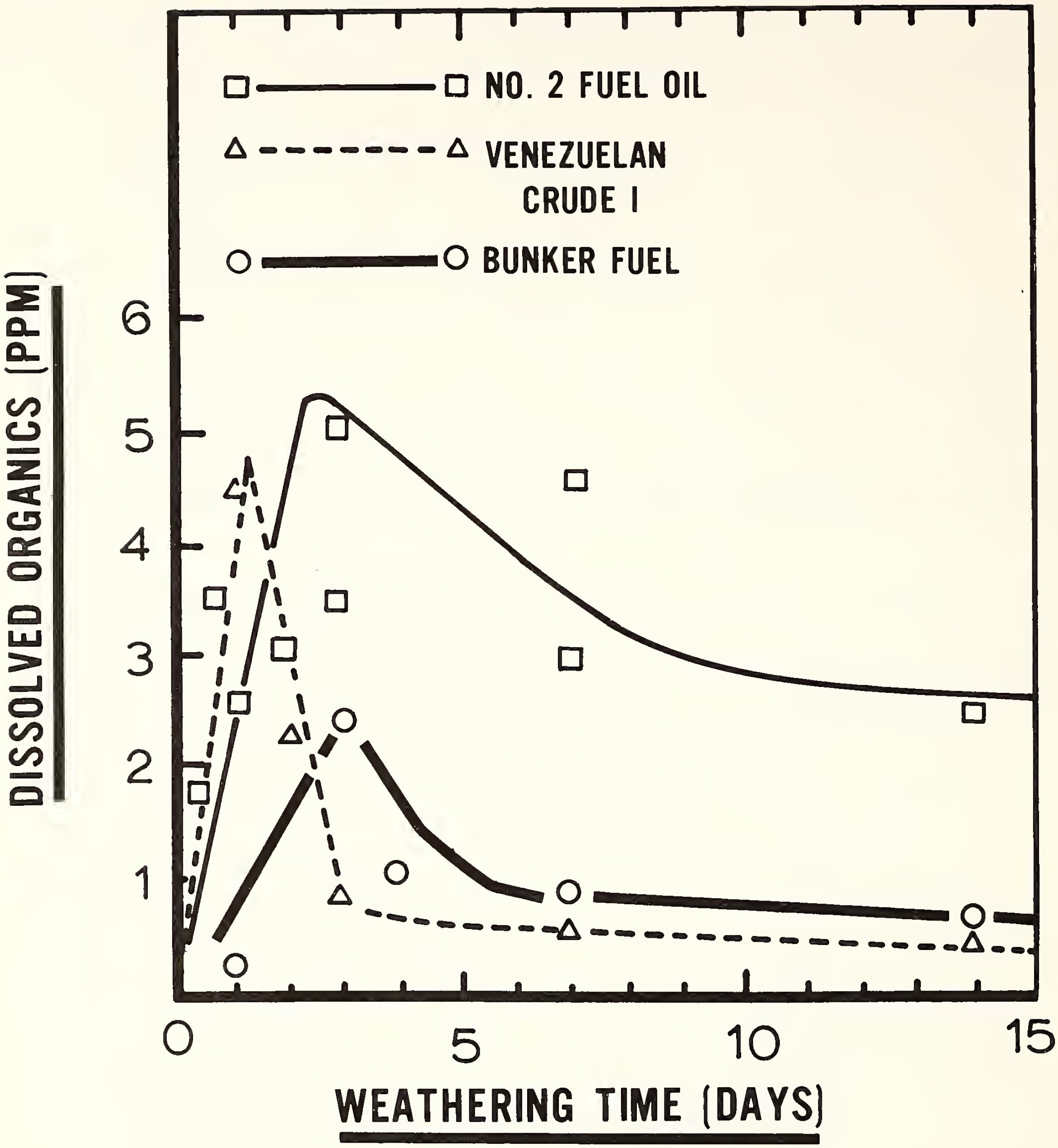

FIG. 5. VARIATION IN DISSOLVED ORGANICS WITH TIME DURING SIMULATED WEATHERING. (FRANKENFELD, 1973).

Chemical Communication

The relatively new field of chemical ecology is concerned with interspecific and intraspecific interactions which are mediated by chemical signals. A recent discussion of chemical communication in the marine environment (21) indicates the complexity of behavorial responses to chemical cues and suggests that chemical communication is a product of eons of coevolution of natural products and their sensors. Whittle and Blumer (22) list several examples of behavior patterns in marine organisms which are known to be controlled by chemical cues. These include securing food, avoiding injury, escaping from enemies, choosing a habitat or host, social communication, migration, recognition of territory and sexual behavior. Thus, chemical communication is one of the most ubiquitous and powerful controlling factors in the marine environment. Interference with this phenomenon has been shown to be produced by petroleum hydrocarbons.

In an attempt to determine the effects of oil pollution on chemo-reception by marine bacteria, Mitchell et. al. (23) added low concentrations of specific aromatic hydrocarbons and crude oil to seawater. The results, presented in Table 9, indicate that

low concentrations of phenol, toluene and crude oil totally inhibit the chemotactic response of marine bacteria.

The bacteria were not immobilized as activity rates remained normal but random. The blockage of the chemoreceptors was reversed when the bacteria were washed free of hydrocarbons, indicating direct inhibition by petroleum products. One of the aromatics inhibited chemoreception more severely than crude oil.

Table 9. Inhibition of the Chemotatic Response by Aromatic Hydrocarbons and Crude Oil (Mitchell et. al., 1972)

Material in capillary	Bacterial attraction
Artificial seawater	1,500
Artificial seawater & glucose	100,000
Artificial seawater & glucose & 0.6% phenol	2,000
Artificial seawater & glucose & 0.6% toluene	1,500
Artificial seawater & glucose & Kuwait crude oil	2,000

Marine bacteria are quite specific in their attraction to organic nutrient sources and Fogel and co-workers (24) has shown that the majority of marine bacteria possess chemoreceptors. These bacteria

are attracted to a food source via chemotaxis; therefore, the microbial decomposition of organic materials in the sea is not only dependent upon the ability of the microorganisms to enzymatically degrade the substrate but is also dependent upon the ability of the degrading organism to detect its substrate. The importance of this mechanism to the cycling of minerals in the pelagic ecosystem is obvious and interference by petroleum could have grave ecological consequences.

Recent research conducted at Woods Hole Oceanographic Institution (25) has shown that small quantities of petroleum inhibit chemoreception in two marine species; the lobster, Homarus americanus and the starfish, Asterias vulgaris. In experiments with the lobster, small quantities of petroleum were sufficient to double the response time for food seeking. In similar studies, the ability of the starfish to detect its prey was inhibited by crude oil.

Rice (26) has shown that fry of the pink salmon, Onchorynchus gorbuscha, are capable of detecting and avoiding very low levels of the water soluble fraction of crude oil. He suggests that such avoidance response could stimulate changes in migration routes.

Kittredge (27) studied the effect of the water soluble components of two crude oils on chemoreceptive response of the lined shore crab, *Pachygrapsus crassipes.* He found that the water soluble extracts completely inhibited both the feeding response and the response to the sex pheromone in dilutions of 1:100 and 1:20 respectively of a solution that had been prepared by gently stirring 2 liters of sea water under a thin film of crude oil.

Thus, one finds sufficient evidence to state that petroleum products are capable of inhibiting what is one of the most ubiquitous and powerful controlling factors in the marine environment, chemical communication. Since chemoreceptors are naturally attuned to water soluble substances, the potency of the water soluble fraction is an important factor to consider in assessing the relative impact of petroleum products upon chemical communication in the marine environment. Hence, light oils could reasonably be expected to have greater impact upon this phenomenon than heavy oils. Further research is necessary in this area to completely elucidate the relative effects of various oils on chemoreception.

Relative Hazard Profile

The relative hazard posed by light versus heavy oils in the pelagic environment has been assessed by considering the five areas mentioned above: acute toxicity, inhibition of photosynthesis, bioaccumulation and carcinogenicity, accomodation and persistence and interference with chemical communication. Those that were quantifiable were given a relative number rating based on measurable effects. These were normalized by having the low number equal to one; therefore, the least harmful group was assigned the unit value and the most harmful was assigned a numeric value representing the relative difference in effects. This approach does not allow for a ranking of the five categories as it was felt that insufficient evidence exists to warrant such a classification.

Acute toxicities were compared by taking the reciprocal of the TLm derived in any particular investigation and averaging these for the two categories of petroleum. Then a ratio was derived for each investigation and these were averaged to produce the final relative ranking. Table 10 shows the derivation of the relative acute toxicity ranking.

TABLE 10 Derivation of Acute Toxicity Ranking

Measured Effect	Light Oils	Heavy Oils	Ratio	Reference
x reciprocal TL_m^{96} x 1000	353.25	60.50	5.8:1	U.S. EPA
x reciprocal TL_m^{48} x 1000	350.00	221.70	1.6:1	Anderson
x reciprocal TL_m^{48} x 1000	8.00	0.40	20.0:1	Tagatz

sum = 27.4:3
mean = 9.1:1, the relative ranking

The relative photosynthetic inhibition caused by light and heavy oils was determined by comparing percent inhibition at a given concentration. Table 11 shows the derivation of the ratio.

TABLE 11 Derivation of Photosynthetic Inhibition Ranking

Measured Effect	Light Oils	Heavy Oils	Ratio	Reference
% inhibition at 200 mg/l	53	25	2.1:1.0	Gordon
% inhibition at 30% oil extract	76	40	1.9:1.0	Nuzzi

sum = 4.0:2.0
mean = 2.0:1.0, the relative ranking

Insufficient data exist to quantify the bioaccumulation and carcinogencity of light and heavy oils in the marine environment. However, since light oils are potentially more carcinogenic than heavy oils, it is desirable to communicate this in the relative hazards profile. Therefore, under this category of harmful effects, light oils will be given a two symbol rating and heavy oils will be given one symbol.

Light and heavy oils were ranked as to accomodation and persistence according to the relative amounts found in the water column after weathering. The derivation of the ranking is presented in Table 12.

TABLE 12 Derivation of Accomodation and Persistence Ranking

Measured Effect	Light Oils	Heavy Oils	Ratio	Reference
ppm in water column after 7 days	10.5	5.0	2.1:1.0	U.S. EPA
ppm in water column after 7 days	3.5	0.7	5.0:1.0	Frankenfeld
	sum = 7.1:2.0			
	mean = 3.5:1.0, the relative ranking			

The relative interference with chemical communication caused by light and heavy oils has been quantified in only one investigation. In this case, the attraction of marine bacteria to an organic substrate was measured. Although the relative difference in effects is not great, this conclusion is based on limited information. Interference with chemical communcation by petroleum products is certainly serious enough to warrant further investigation. The derivation of the relative interference rating is shown in Table 13.

TABLE 13 Derivation of Chemical Communication Ranking

Measured Effect	Light Oils	Heavy Oils	Ratio	Reference
% inhibition of positive chemotaxis	98.3	98.0	1.0:1.0	Mitchell, et. al.

Applying the above rankings, a relative hazards profile was developed for light oils for the five categories of effect. This is presented in Table 14.

TABLE 14 Relative Harmful Effects Profile for Light and Heavy Oils

Category of Effects	Light Oils	Heavy Oils
acute toxicity	9.1	1.0
inhibition of photosynthesis	2.0	1.0
bioaccumulation & carcinogenicity	**	*
accomodation & persistence	3.5	1.0
chemical communication interference+	1.0	1.0

*insufficient data to quantify
**based on limited information; the difference could be much greater

This profile demonstrates that light oils are distinctly more harmful than heavy oils in those categories of harmful effect that apply to pelagic ecosystems. Carcinogenicity and chemoreception are two areas sorely in need for further research.

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